GMP+ International

Kontrol af restkoncentrationer

GMP+ BA 2

Version DN: 1. april 2019

GMP+ Feed Certification scheme

Feed Safety Worldwide

gmpplus.org

Dokumentets historik

Revisionsnr. Dato for godkendelse	Ændring	Vedr.	Dato for endelig implementering
0.0 / 06-2014	Dette er et nyt dokument. Indholdet består af den tidligere del B i GMP+ BA1 *Produktstandarder* og den tidligere del B i GMP+ BA4 *Prøvetagning og analyse*. En række krav er blevet opdateret.	Hele dokumentet	01.01.2015 med undtagelse af afsnit 4.2.4 og 4.2.5, som skal være implementeret senest 01.10.2015
1.0 / 04-2017	Metoder til måling af homogenitet af tørblandinger tilsættes Forkerte referencer tilpasset	6 5	01.07.2018
1.1 / 05-2018	Ændring af standarden for Decoquinat som følge af ændringer i lovgivningen	Kapitel 3	01.07.2018
2.0 / 01-2019	Følgende er blevet ændret: - afsnit 5.7: opdatering af kontrolprocedure for procesnøjagtighed vedr. foderblandinger med mikrosporstoffer - tilføjelse af vigtig note i afsnit 5.4, 5.8 og 5.9	Kapitel 5	01.04.2019

Redaktionel bemærkning:
Alle ændringer i denne udgave af dokumentet er gjort synlige. Ny og gammel tekst er angivet som følger:
- Ny tekst
- ~~Gammel tekst~~

Deltageren skal implementere ændringerne senest pr. den dato, der er angivet for endelig implementering.

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1 INTRODUKTION

1.1 Generelt

GMP+ Feed Certification scheme blev udviklet og iværksat i 1992 af den hollandske foderindustri som svar på forskellige mere eller mindre alvorlige tilfælde af forurening af fodermidler. Selvom den startede med at være en national ordning, har den nu udviklet sig til en international ordning, som administreres af GMP+ International i samarbejde med forskellige internationale interessenter.

Skønt GMP+ Feed Certification scheme blev skabt ud fra et perspektiv om fodersikkerhed, blev den første standard omhandlende foderansvarlighed dog udgivet i 2013. Til dette formål blev der udviklet to moduler: GMP+ Feed Safety Assurance (indeholdende krav til fodersikkerhed) og GMP+ Feed Responsibility Assurance (indeholdende krav til foderansvarlighed).

GMP+ Feed Safety Assurance er et komplet modul med standarder, som skal sikre fodersikkerheden i alle led af foderkæden. Påviselig sikring af fodersikkerheden giver i mange lande og på mange markeder "licens til at sælge", og deltagelse i GMP+ FSA module kan på en fortrinlig måde gøre dette nemmere. På grundlag af behovene i praksis er mange komponenter blevet integreret i GMP+ FSA standarderne såsom krav om et feed safety management system (system til styring af fodersikkerheden), anvendelsen af HACCP-principper, sporbarhed, kontrol, forudsætningsprogrammer, fokus på foderkæden og Early Warning System.

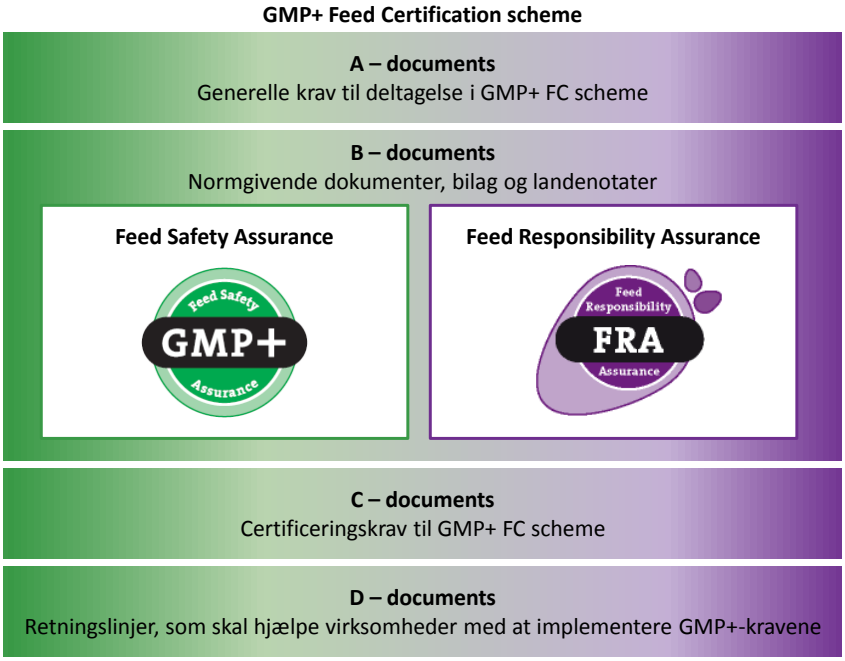
Med udviklingen af GMP+ Feed Responsibility Assurance module reagerer GMP+ International på anmodninger fra GMP+ deltagerne. Fodersektoren konfronteres med anmodninger om at arbejde mere ansvarligt. Dette omfatter f.eks. indkøb af soja og fiskemel, der produceres og afsættes med respekt for mennesker, dyr og miljø. En virksomhed kan blive certificeret i henhold til GMP+ Feed Responsibility Assurance og på den måde vise, at virksomheden producerer og afsætter sine varer på en ansvarlig måde. GMP+ International gør det nemmere via uafhængig certificering at opfylde markedets krav.

Sammen med GMP+ partnerne stiller GMP+ International på en gennemsigtig måde klare krav i Feed Certification scheme. Certificeringsorganer kan uafhængigt gennemføre GMP+ certificering.

GMP+ International støtter GMP+ deltagerne med brugbare og praktiske oplysninger i form af en række vejledende dokumenter, databaser, nyhedsbreve, Svar&Spørgsmål-lister og seminarer.

1.2 Strukturen i GMP+ Feed Certification scheme

Dokumenterne i GMP+ Feed Certification scheme er underopdelt i en række serier. Den næste side viser et skematisk overblik over indholdet i GMP+ Feed Certification scheme:



Alle disse dokumenter findes på GMP+ Internationals websted (www.gmpplus.org).

Dette dokument kaldes GMP+ BA2 *Kontrol af restkoncentrationer* og er en del af GMP+ FSA scheme.

1.3 Anvendelsesområde

Dette dokument fastlægger specifikke krav til kontrol af restkoncentrationer af en række veterinærlægemidler og fodertilsætningsstoffer.

- Afsnit 2 indeholder en række generelle krav
- Afsnit 3 indeholder grænseværdier for restkoncentrationer af en række veterinærlægemidler og fodertilsætningsstoffer. Disse grænseværdier må ikke overskrides.

Forklaring
Tilstedeværelsen af restkoncentrationer af veterinærlægemidler og fodertilsætningsstoffer i mælk, kød eller æg er kritisk og dermed uønsket. Niveauet af disse restkoncentrationer i foder skal kontrolleres og må ikke overstige visse grænseværdier.

- Afsnit 4 indeholder yderligere krav til kontrol af disse kritiske veterinærlægemidler og fodertilsætningsstoffer. Afsnittet indeholder flere forskellige kontrolforanstaltninger.

- Afsnit 5 beskriver en række protokoller til brug ved måling af overslæb i et foderproduktionsanlæg. En af disse protokoller skal anvendes ved måling af overslæbsprocenten i installationer, anlæg og udstyr. Hvis national lovgivning imidlertid kræver, at der anvendes bestemte metoder til måling af overslæb, accepteres disse metoder og deres resultater også.

2 Baggrundsoplysninger

1. Korrekt brug af fodertilsætningsstoffer og veterinærlægemidler i produktionen af foder(blandinger) eller forblandinger bidrager til foder- og fødevaresikkerhed. GMP+ standarder indeholder derfor krav til kontrol af anvendelsen af veterinærlægemidler og fodertilsætningsstoffer, herunder restkoncentrationer. Deltageren skal sikre, at

   a. de korrekte fodertilsætningsstoffer og veterinærlægemidler doseres i den rigtige mængde i det rigtige foder.
   b. (restkoncentrationer af) disse fodertilsætningsstoffer og veterinærlægemidler ikke er til stede i noget andet foder eller i det mindste ikke overstiger maksimumsgrænserne (de såkaldte grænseværdier).

2. Grænseværdierne for restkoncentrationer, der nævnes i dette dokument, er hovedsageligt baseret på EU-lovgivning. Disse grænseværdier for restkoncentrationer indarbejdes i GMP+ FSA module. Enhver virksomhed, der deltager i GMP+ FC scheme, uanset om pågældende virksomhed er beliggende i eller uden for Europa, skal – hvis dette er relevant – overholde disse grænseværdier for restkoncentrationer.

   Generelt udgør grænseværdien for et bestemt fodertilsætningsstof en procentdel af det maksimale indhold, som må iblandes foderet. I EU-foderstoflovgivningen fastsættes grænseværdierne for restkoncentrationer på grundlag af faktorerne i følgende tabel.

Fodertilsætningsstof	Maks. procentdel (%)	Bemærkning
Coccidiostatika	1	For kritisk foder
	3	For kritisk foder
Antibiotika	2,5	

   Disse grænseværdier beskrives nærmere i tabellen i afsnit 3. Denne tabel indeholder også grænseværdier for restkoncentrationer af en række andre stoffer primært beregnet med en "maks. faktor på 2,5 %".

3. EU-lovgivningen angiver udelukkende grænseværdier for restkoncentrationer for de fodertilsætningsstoffer, der er godkendt i EU til anvendelse i foder. I andre dele af verden er andre stoffer (bestemte coccidiostatika "veterinærlægemidler" eller produkter såsom Olaquindox og Carbadox) også godkendt til brug som veterinærlægemidler eller fodertilsætningsstoffer. Grænseværdierne for restkoncentrationer af disse produkter skal beregnes på grundlag af de procentdele, der er angivet ovenfor. Disse produkter er i tabellen i afsnit 3 klassificeret som "Andre stoffer, for hvilke der er fastsat en tilbageholdelsestid".

   Vejledning
   "Andre stoffer, for hvilke der er fastsat en tilbageholdelsestid" er produkter
   - *der bevidst tilsættes foderet med den hensigt at påvirke ydelse, produktion eller dyrets sundhed, og*
   - *som kan findes i animalske produkter (kød, mælk eller æg), og som kan være skadelige, hvis de indtages af mennesker, og*
   - *for hvilke der efterfølgende er blevet fastsat en tilbageholdelsestid.*

4. De lovkrav, som gælder for brugen af fodertilsætningsstoffer og veterinærlægemidler, skal overholdes, herunder kravene til dosering og mærkning. Såfremt lovgivningen kræver overholdelse af andre grænseværdier, skal disse krav også overholdes.

Vejledning *Bemærk, at GMP+ kravene hovedsageligt er baseret på EU-lovgivning. Dette betyder dog – for eksempel – ikke, at en virksomhed, der ligger uden for Europa, ikke må fremstille eller forarbejde et fodertilsætningsstof, der ikke er godkendt i EU. Et sådant fodertilsætningsstof kan fremstilles eller forarbejdes på GMP+ betingelser, og det system, som denne produktion er baseret på, kan være GMP+ certificeret. Et sådant fodertilsætningsstof kan dog ikke bruges som fodertilsætningsstof i foder til EU-markedet. Et GMP+ certifikat udgør ikke en licens til at kunne eksportere til Europa.*

3 Grænseværdier for kritiske restkoncentrationer

Følgende tabel viser grænseværdierne for kritiske restkoncentrationer af en række fodertilsætningsstoffer/veterinærlægemidler.

Fodertilsætningsstoffer	Produkter bestemt til foder	Maksimalindhold i mg/kg (ppm) i forhold til et foderstof med et vandindhold på 12 %
Lasalocid A-natrium	Fodermidler	1,25
	Foderblandinger til: - hunde, kalve, kaniner, dyr af hestefamilien, malkedyr, læggefugle, kalkuner (> 16 uger) og hønniker (> 16 uger) - slagtekyllinger, hønniker (< 16 uger) og kalkuner (< 16 uger) i perioden inden slagtning, hvor brugen af lasalocid A-natrium er forbudt (tilbageholdelsesfoder) - andre dyrearter	1,25 1,25 3,75
	- fasaner, perlehøns, vagtler og agerhøns (undtagen læggefugle) i perioden inden slagtning, hvor brugen af lasalocid A-natrium er forbudt (tilbageholdelsesfoder)	1,25
	Forblandinger til brug i foder, hvor brugen af lasalocidnatrium ikke er tilladt.	(1)
Narasin	Fodermidler	0,7
	Foderblandinger til: - kalkuner, kaniner, dyr af hestefamilien, læggefugle og hønniker (> 16 uger) - andre dyrearter	0,7 2,1
	Forblandinger til brug i foder, hvor brugen af narasin ikke er tilladt.	(1)
Salinomycin-natrium	Fodermidler	0,7
	Foderblandinger til: - dyr af hestefamilien, kalkuner, læggefugle og hønniker (> 12 uger) - slagtekyllinger, hønniker (< 12 uger) og slagtekaniner i perioden inden slagtning, hvor brugen af salinomycinnatrium er forbudt (tilbageholdelsesfoder) - andre dyrearter	0,7 0,7 2,1
	Forblandinger til brug i foder, hvor brugen af salinomycinnatrium ikke er tilladt.	(1)
Monensin-natrium	Fodermidler	1,25

Fodertilsætningsstoffer	Produkter bestemt til foder	Maksimalindhold i mg/kg (ppm) i forhold til et foderstof med et vandindhold på 12 %
	Foderblandinger til: - dyr af hestefamilien, hunde, mindre drøvtyggere (får og geder), ænder, kvæg, malkedyr, læggefugle, hønniker (> 16 uger) og kalkuner (> 16 uger) - slagtekyllinger, hønniker (< 16 uger) og kalkuner (< 16 uger) i perioden inden slagtning, hvor brugen af monensinnatrium er forbudt (tilbageholdelsesfoder) - andre dyrearter	1,25 1,25 3,75
	Forblandinger til brug i foder, hvor brugen af monensinnatrium ikke er tilladt.	(1)
Semduramicinnatrium	Fodermidler:	0,25
	Foderblandinger til: - læggefugle og hønniker (> 16 uger) - slagtekyllinger i perioden inden slagtning, hvor brugen af semduramicinnatrium er forbudt (tilbageholdelsesfoder) - andre dyrearter	0,25 0,25 0,75
	Forblandinger til brug i foder, hvor brugen af semduramicinnatrium ikke er tilladt.	(1)
Alphamaduramicinammonium	Fodermidler	0,05
	Foderblandinger til: - dyr af hestefamilien, kaniner, kalkuner (> 16 uger), læggefugle og hønniker (> 16 uger) - slagtekyllinger og kalkuner (< 16 uger) i perioden inden slagtning, hvor brugen af alphamaduramicin-ammonium er forbudt (tilbageholdelsesfoder) - andre dyrearter	0,05 0,05 0,15
	Forblandinger til brug i foder, hvor brugen af alphamaduramicinammonium ikke er tilladt.	(1)
Robenidinhydrochlorid	Fodermidler	0,7
	Foderblandinger til: - læggefugle og hønniker (> 16 uger) - slagtekyllinger, slagte- og avlskaniner og kalkuner i perioden inden slagtning, hvor brugen af robenidinhydrochlorid er forbudt (tilbageholdelsesfoder) - andre dyrearter	0,7 0,7 2,1
	Forblandinger til brug i foder, hvor brugen af robenidinhydrochlorid ikke er tilladt.	(1)

Fodertilsætningsstoffer	Produkter bestemt til foder	Maksimalindhold i mg/kg (ppm) i forhold til et foderstof med et vandindhold på 12 %
Decoquinat	Fodermidler	0,4
	Foderblandinger til: - læggefugle og hønniker (> 16 uger) - andre dyrearter	 0,4 1,2
	Forblandinger til brug i foder, hvor brugen af decoquinat ikke er tilladt.	([1])
Halofuginon-hydrobromid	Fodermidler	0,03
	Foderblandinger til: - læggefugle, hønniker og kalkuner (> 12 uger) - slagtekyllinger og kalkuner (< 12 uger) i perioden inden slagtning, hvor brugen af halofuginonhydrobromid er forbudt (tilbageholdelsesfoder) - andre dyrearter	 0,03 0,03 0,09
	Forblandinger til brug i foder, hvor brugen af halofuginonhydrobromid ikke er tilladt.	([1])
Nicarbazin	Fodermidler	1,25
	Foderblandinger til: - dyr af hestefamilien, læggefugle og hønniker (> 16 uger) - andre dyrearter	 1,25 3,75
	Forblandinger til brug i foder, hvor brugen af nicarbazin (kombineret med narasin) ikke er tilladt.	([1])
Diclazuril	Fodermidler	0,01
	Foderblandinger til: - læggefugle, hønniker (> 16 uger) - slagte- og avlskaniner i perioden inden slagtning, hvor brugen af diclazuril er forbudt (tilbageholdelsesfoder) - andre dyrearter end hønniker (< 16 uger), slagtekyllinger, perlehøns og slagtekalkuner	 0,01 0,01 0,03
	Forblandinger til brug i foder, hvor brugen af diclazuril ikke er tilladt.	([1])

Fodertilsætningsstoffer	**Produkter bestemt til foder**	**Maksimalindhold i mg/kg (ppm) i forhold til et foderstof med et vandindhold på 12 %**
	Bemærk: • Slagtekyllinger: foder, som gives til disse kyllinger fra 5 dage før slagtning • Slagtekalkuner: foder, som gives til disse kalkuner fra 5 dage før slagtning • Svin: foder, som gives til svin fra 28 dage før slagtning	
For andre coccidiosta-tika	Alt foder	1 % af det maksimalindhold, som er godkendt til iblanding i foderet.
Veterinærlægemidler	**Produkter bestemt til foder**	**Maksimalindhold i mg/kg (ppm) i forhold til et foderstof med et vandindhold på 12 %**
Sulfadiazinnatrium	Foderblandinger til: - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	 5 8 1 1
Sulfamethoxazol	Foderblandinger til - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	 5 8 1 1
Doxycyclin	Foderblandinger til - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	 8 8 10 1 batch[2]
Oxytetracyc-lin	Foderblandinger til - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	 1 10 10 1 batch[2]
Ivermectin	Foderblandinger til - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	 0,1 0,1 0,1 1 batch[2]
Tiamulin	Foderblandinger til - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	 1 8 10 1 batch[2]

Veterinærlægemidler	**Produkter bestemt til foder**	**Maksimalindhold i mg/kg (ppm) i forhold til et foderstof med et vandindhold på 12 %**
Tilmicosin	Foderblandinger til - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	 1 4 10 1 batch[2]
Trimethoprim	Foderblandinger til - Læggefugle - Slagtekyllinger og slagtekalkuner - Svin - Malkedyr	Knyttet til sulfadiazin og derfor tilstrækkeligt garanteret
Andre foder-tilsætnings-stoffer/vete-rinærlæge-midler	**Produkter bestemt til foder**	**Maksimalindhold i mg/kg (ppm) i forhold til et fo-derstof med et vandindhold på 12 %**
Andre stof-fer, for hvilke der er fastsat en tilbageholdel sestid[3]	Alle andre foderstoffer til dyr, der producerer animalske produkter, såsom - Æglæggende høns - Mælkeproducerende køer, geder, får osv. - Slagtekyllinger og slagtekalkuner (foder, der gives fra 5 dage før slagtning) - Svin (foder, der gives fra 28 dage før slagtning)	1

(1) Maksimalgrænseværdien for stoffet i forblandingen er den koncentration, som ikke medfører et indhold af stoffet på over 50 % af de fastsatte maksimalgrænseværdier i foderet, når brugsanvisningen for forblandingen følges.

(2) Foder til malkekvæg må ikke umiddelbart fremstilles på en produktionslinje, som netop er blevet brugt til produktion, hvor disse tilsætningsstoffer/produkter indgår.

(3) Eksempler: Flubendazol, Carbadox, Olaquindox.

4 Yderligere krav til kontrol af restkoncentrationer

4.1 Generelt

En virksomhed kan anvende flere kontrolforanstaltninger for at sikre, at rester af kritiske fodertilsætningsstoffer og veterinærlægemidler ikke overskrider de grænseværdier, der er fastsat i tabellen i afsnit 3.

Vejledning
Overvej eller sørg for:
- *slet ikke at anvende fodertilsætningsstoffer, for hvilke der er fastsat en grænseværdi for restkoncentration.*
- *at adskille de områder, hvor der anvendes fodertilsætningsstoffer/veterinærlægemidler fra de områder, hvor de ikke anvendes.*
- *at adskille produktionsudstyr og interne transportfaciliteter (med og uden kritiske fodertilsætningsstoffer/veterinærlægemidler) inden for et produktionssted.*
- *at vælge mindre kritiske fodertilsætningsstoffer eller veterinærlægemidler.*
- *at transportere de første 50-100 kg produceret foder (efter produktion med foderlægemidler) til genforarbejdningsbeholderen.*
- *at anvende særligt udstyr (intern transport, blander, filter).*
- *at rengøre og vedligeholde udstyret korrekt.*
- *at dosere veterinærlægemidler i blanderen eller bulk-blandingsudstyret.*
- *at anvende en fast doseringsrækkefølge for mikrokomponenter.*
- *at anvende korte transportveje og korrekte tomgangsperioder.*
- *at undgå, at der er steder i udstyret, hvor (rest)produkter kan blive siddende.*
- *at anvende en streng produktionsrækkefølge/skylning. Se afsnit 4.2.*

Alle GMP+ standarder foreskriver, at kontrolforanstaltninger skal valideres, og at deres effektivitet skal verificeres med passende hyppighed ("HACCP-principper'). Dette gælder for foranstaltningerne til kontrol af restkoncentrationer af veterinærlægemidler/tilsætningsstoffer.

Når der anvendes en bestemt produktionsrækkefølge til kontrol af grænseværdier for restkoncentrationer, skal der anvendes en bestemt validerings- og verifikationsprocedure. Se afsnit 4.2.4.

Vejledning
Validering: Skal anvendes i overensstemmelse med de fælles HACCP-principper. Deltageren skal være sikker på, at anvendelsen af en bestemt kontrolforanstaltning giver det forventede resultat (= ingen restkoncentrationer eller restkoncentrationer, der ligger under grænseværdierne). Resultater af analytisk forskning er i den forbindelse meget nyttige. Efter hver væsentlig ændring skal kontrolforanstaltningerne revurderes, og – om nødvendigt – opdateres og valideres.

Verifikation: Fra tid til anden skal det tjekkes, om den anvendte kontrolforanstaltning stadig giver det forventede resultat (= ingen restkoncentrationer eller restkoncentrationer, der ligger under grænseværdierne).

4.2 Kontrol af restkoncentrationer via produktionsrækkefølgen

4.2.1 Generelt

En meget almindelig metode til kontrol af restkoncentrationsniveauet er at skylle produktionsanlægget igennem og på den måde "rengøre" anlægget, efter at der er blevet anvendt et veterinærlægemiddel eller et fodertilsætningsstof.
Når denne metode anvendes, skal der udregnes og anvendes en streng produktionsrækkefølge, som indeholder tilstrækkelig med skylningsbatches til at sikre, at grænseværdierne for restkoncentrationer ikke overskrides.

Hvis foder anvendes til skylning, efter at et foderlægemiddel eller foder med et coccidiostatikum er blevet produceret, skal det sikres, at restkoncentrationen af veterinærlægemidler eller fodertilsætningsstoffer i dette foder ikke overskrider grænseværdierne.

Hvis et fodermiddel anvendes til skylning, skal dette fodermiddel efterfølgende anvendes eller forarbejdes med stor forsigtighed. En risikoanalyse vil kunne vise, hvordan dette fodermiddel anvendes korrekt. Dette fodermiddel kan muligvis anvendes i et foder, som indeholder det samme coccidiostatikum eller antibiotika. Det kan også bortskaffes som affald.

Den beregning, der er baseret på graden af overslæb i et produktionsanlæg, resulterer i forventede (beregnede) niveauer af restkoncentrationer af kritiske fodertilsætningsstoffer og veterinærlægemidler i batches, der produceres efter et batch, hvor en virksomhed har anvendt et kritisk fodertilsætningsstof eller veterinærlægemiddel.

Bemærk:
Maksimalgrænseværdien for fodertilsætningsstoffet/veterinærlægemidlet i forblandingen er den koncentration, som ikke medfører et indhold af dette fodertilsætningsstof/veterinærlægemiddel på over 50 % af de fastsatte maksimalgrænseværdier i foderet, når brugsanvisningen for forblandingen følges.

Vejledning
Eksempel: Maksimalgrænseværdien for restkoncentrationen af et fodertilsætningsstof til foder er 1 ppm. Forblandingen må bidrage med maks. 0,5 ppm i foderet (50 %). Når forblandingen skal blandes i foderet med 5 % ifølge brugsanvisningen, er maksimalgrænseværdien for forblandingen 10 ppm.

Der er også fastsat maksimalgrænseværdier for fodertilsætningsstoffer som kobber og zink. Disse maksimalgrænseværdier må ikke overskrides. Se GMP+ BA1. Sørg for, at disse grænseværdier ikke overskrides.

4.2.2 Overslæbsprocent i anlæg

4.2.2.1 Generelt

Testproceduren, som beskrives i afsnit 5 i dette dokument, skal anvendes til måling af overslæbsprocenten i et anlæg. Alle produktions-, forarbejdnings- og transportlinjer i et anlæg, der kan bidrage til overslæb, skal testes. Yderligere oplysninger fremgår af afsnit 5.

4.2.2.2 Hyppighed

Minimumshyppigheden for måling af overslæb i produktions- og transportlinjer afhænger af de (det foder og de forblandinger med) fodertilsætningsstoffer og veterinærlægemidler, som deltageren forarbejder, og om deltageren forarbejder foder, for hvilket der er fastsat en grænseværdi for restkoncentrationer.

Hvis deltageren forarbejder eller transporterer (foder indeholdende) produkter, for hvilke der er fastsat en specifik grænseværdi for restkoncentrationer i tabellen i afsnit 3, skal overslæbsprocenten kendes for de linjer, hvor disse produkter forarbejdes, produceres eller transporteres. Hvis deltageren har sådanne produktionslinjer, skal vedkommende måle overslæbet mindst én gang hver andet år.

Hvis deltageren forarbejder eller transporterer andre produkter, der kan give restkoncentrationer i animalske produkter, skal vedkommende måle overslæbet mindst én gang.

Overslæbet skal måles igen, hvis der foretages store ændringer i anlægget.

4.2.3 Sikkerhedsfaktor

Et kritisk fodertilsætningsstofs eller veterinærlægemiddels faktiske forarbejdningsegenskaber kan være forskellige fra de sporstoffer, der anvendes ved målingen af overslæbsprocenten ved hjælp af en af de metoder, som beskrives i afsnit 5.

For at opnå flere garantier for at de faktiske restkoncentrationer ikke overstiger de beregnede (forventede) restkoncentrationer, kan en virksomhed i beregningen af produktionsrækkefølgen anvende en såkaldt sikkerhedsfaktor. Hvis en virksomhed anvender en sikkerhedsfaktor i beregningen, kan den sænke verifikationshyppigheden. Se afsnit 4.2.4.

Standardsikkerhedsfaktoren, der skal anvendes, er "3". Tabellerne i afsnit 4.2.5 fastsætter dog andre sikkerhedsfaktorer for en række kritiske fodertilsætningsstoffer og veterinærlægemidler.

Vejledning

Disse sikkerhedsfaktorer bestemmes på grundlag af en såkaldt relativ vægvedhæftningsfaktor, som måles ved hjælp af en test, der er specielt udviklet til dette formål. Hvis en virksomhed ønsker at anvende denne test til fastsættelse af vægvedhæftningsfaktoren, kan virksomheden kontakte GMP+ International.

4.2.4 Validering og periodisk verifikation ("kontrolovervågning")

4.2.4.1 Validering

En beregnet produktionsrækkefølge skal valideres korrekt for at være effektiv i kontrollen af restkoncentrationer. Der skal udtages og analyseres mindst to prøver.

Når overslæbsgraden er blevet målt på ny, og produktionsrækkefølgen er blevet beregnet på ny, skal der foretages en ny validering.

4.2.4.2 Verifikation

For at bevise den løbende effektivitet af den anvendte produktionsrækkefølge skal virksomheden ved at foretage en analyse kontrollere restkoncentrationerne i relevante foderstoffer:

a) Hvis sikkerhedsfaktoren ikke anvendes i beregningen af produktionsrækkefølgen: 4 prøver pr. år
b) Hvis sikkerhedsfaktoren anvendes i beregningen af produktionsrækkefølgen: 2 prøver pr. år

Vejledning
Virksomheden har et valg her. Hvis sikkerhedsfaktoren anvendes, er minimumskontrolhyppigheden lavere.

Verifikation skal foretages ved at analysere restkoncentrationerne af det specifikke veterinærlægemiddel eller fodertilsætningsstof. Når der anvendes flere veterinærlægemidler eller fodertilsætningsstoffer i produktionen, skal det med den højeste sikkerhedsfaktor analyseres som en del af verifikationen.

Analyse skal foretages af et godkendt laboratorium (se GMP+ BA10). Detekteringsgrænsen for den metode, der anvendes, skal kunne afgøre, om det etablerede system for produktionsrækkefølgen er tilstrækkeligt.

4.2.5 Yderligere oplysninger om sikkerhedsfaktoren

Tabel 1: Yderligere oplysninger om sikkerhedsfaktoren for nogle coccidiostatika og histomonostatika, som er blevet testet med den såkaldte vægvedhæftningstest.

Navn	Producent	Sikkerhedsfaktor	
		Svin	Andet
Forbindelse af narasin og nicarbazin			
Maxiban G 160 forblanding	Eli Lilly	3	1
Lasalocidnatrium			
Avatec 15 % CC	Roche	1	1
Robenidinhydrochlorid			
Cycostat 66G	Roche	1	1
Monensinnatrium			
Elancoban G200 forblanding	Eli Lilly	1	1
Coxidin (5 1 70 1)	Huvepharma	1	1
Narasin			
Monteban G100 forblanding	Eli Lilly	1	1
Halofuginonhydrobromid (764)			
Stenorol	Huvepharma	1	1
Diclazuril			
Clinacox 0,5 % forblanding	Janssen Pharmaceutica nv	2	2
Salinomycinnatrium			
Sacox 120 mikrogranulat	Huvepharma	1	1
Kokcisan 12 %	KRKA	1	1

Tabel 2: Yderligere oplysninger om sikkerhedsfaktoren for en række forblandinger til foderlægemidler, som er blevet testet med den såkaldte vægvedhæftningstest.

Navn	Producent/importør	Sikkerhedsfaktor	
		Svin	Andet
Doxycyclinhyclat/bromhexin-hydrochlorid			
Foderblanding Doxy-B	Dopharma Research B.V.	2,5	2,5
Pulmodox 5 %, forblanding	Virbac Laboratories	2,5	2,5
Doxyprex	Industrial Veterinaria S. A.	2,5	2,5
Sulfadiazinnatrium/Trimetoprim			
Foderblanding Trim/sul 80/420	Aesculaap BV	3	3
Trimethosulf, forblanding	Eurovet Animal Health BV.	3	2
Foderblanding sulfatrim	Dopharma Research B.V.	3	3
Sulfamethoxazol/Trimetoprim			
Foderblanding TS	Dopharma Research B.V.	3	3
Vetmulin 10 %, forblanding til foderlægemiddel	Huvepharma N.V.	1	1
Tilmicosinfosfat			

Navn	Producent/importør	Sikkerhedsfaktor	
		Svin	Andet
Tilmovet 10 %, forblanding til foderlægemiddel til svin	Huvepharma N.V.	1	1
Tilmovet 4 %	Huvepharma N.V.	1	1
Tilmovet 20 %, forblanding til foderlægemiddel til svin	Huvepharma N.V.	1	1
Tylosinfosfat			
Pharmasin 20 mg/g forblanding	Huvepharma N.V.	1	1
Pharmasin 100 mg/g forblanding til foderlægemiddel til svin, slagtekyllinger og hønniker	Huvepharma N.V.	1	1
Pharmasin 250 mg/g forblanding til foderlægemiddel til svin, slagtekyllinger og hønniker	Huvepharma N.V.	1	1
Flubendazol (forskellige blandinger)		3	3
Ivermectin (forskellige blandinger)		3	3

Resten af dette dokument er på engelsk.

5 METHODS FOR MEASURING CARRY-OVER

5.1 Introduction

To measure the carry-over, the participant must make use of the protocols, which are laid down in this part of the appendix.

The report on the carry-over inspection must comply with further conditions. See below for a description of the methods. (see chapter 2, section: Inspection report)

N.B.
It is permissible for companies to deviate from the method laid down as long as the principle is not affected and it can be demonstrated that equivalent results will be obtained.

In some countries, in legislation special requirements to measure the carry-over are laid down. The results of these measurements are accepted to demonstrate compliance with the GMP+ requirements.

5.2 General basic principles with respect to the measurement of carry-over

When measuring the carry-over of additives in an installation there must be a prior examination using a block diagram (graphic reproduction of e.g. a factory) and the actual situation in the factory of which parts of the factory may be relevant for carry-over.

A basic principle in determining carry-over in a company is that the degree of carry-over as a result of return flows is known and is controlled.

Carry-over points

Carry-over in a (compound feed) factory may occur in the following processes.

1. **The filling of premix silos**
   The filling of the premix silos may be the cause of carry-over. The block diagram can be used to find out whether there are reasons to suppose that carry-over occurs here. Critical points are common transport systems, chutes, separation systems and filters.

   In mechanical transports such as mass transports, elevators and screw conveyors, carry-over always occurs and it is sensible to measure this carry-over. Also, sufficiently long idle times (10 minutes) should be taken into account.

   For the pneumatic filling method with separate filters for each silo, no account needs to be taken of carry-over. If there is a common filter then the filter must, for at least 10 minutes after unloading, be knocked on the same silo as that in which the filling took place.

   There should be an instruction for the dumping sequence so that undesired mixing does not take place.

   In this situation it must be certain that unacceptable residue levels no longer occur.

2. **Dosage, grinding and mixing line**
   The greatest amount of carry-over of additives and veterinary medical products occurs in the dosage process (addition of additives or veterinary medical products) / (possibly grinding) / mixing / transport and storage of the product in meal form in a finished product cell or a pressed meal cell.

   The place where premixes are added should be as close to the mixer as possible. It is important that the measured substance is added at the same place as where the additive and veterinary medical products were added.

3. Press line

A considerable amount of carry-over can occur in the press line. The carry-over increases as the press moulds are bigger. In addition, interim bunkers containing stocks can be a source of carry-over.

An item for attention is the return flows which are brought back directly into the pressed meal silo during pelletising.

4. Loading and transport

During storage, loading and transport of a finished product there will only be carry-over of any importance for highly critical additives and veterinary medical products (for example nicarbazine and sulfa-veterinary medical products). In these cases a mandatory working sequence should be used.

An item for attention is the processing of the sievings from the bulk load. Possible processing of such sievings must at least comply with the animal feed legislation and must therefore be processed in a careful and controlled fashion. Any sievings of medicated feed may not be reprocessed.

If the undesired carry-over of critical additives and veterinary medical products may be expected than company may take the following measures:

1. the drawing up of a mandatory production (working) sequence
2. additional measures in the event of product changes
3. the production of feeds with critical additives and veterinary medical products on another line
4. switching to less critical agents.

Measurement points for carry-over

The major causes of carry-over are the dosage / grinding / mixing line and the press line. The carry-over should be known if both feeds with critical additives and veterinary medical products as feeds with a maximum carry-over level are produced on these lines. In order to establish this reliably the following measurement points are important:

After the mixer, but as close as possible to the mixer for the measurement of the output content of the mixer:

a. at the entry to the pressed meal cell in grain production or the finished product cell in meal production, for the measurement of the carry-over on the dosage / grinding / mixing line
b. at the entry to the finished product cell in grain production for the measurement of carry-over on the press line.

Carry-over which is determined in this way is considered to be the installation carry-over.

Possible measurement substances

For the sake of reliability it is important to choose a measurement substance which can also be analysed properly at low levels. The following measurement substances are permitted. An indication is also given of to what degree of accuracy these means can be used to determine the carry-over in an installation.

Method	Chapter	Lower limit[1] of carry-over inspection accuracy in % [1)]
Cobalt chloride 100 ppm	5.4	1
Cobalt sulphate - 100 ppm - 50 ppm - 25 ppm	 5.4.1 4.2.1 4.2.2	 1 3 5
Protein/Manganate	5.5	See the table in 5.5
FSS-Lake 100ppm	5.7	1
F-Lake 100 ppm	5.7	1
FSS-Lake 10 ppm	5.7	1
RF microtracer (by way of weighing)	5.8	1
Methyl violet	5.9	1

[1)] *Chapter5.6 includes a method for the measurement of the carry-over for the production system for premixes and feed additives*

Inspection report

Good reporting on the inspection is important to be able to apply the results unambiguously when determining measures and during supervision of the correct implementation. This should be based on a well thought out and properly described protocol which has been talked through in advance with those who will implement it and on a careful implementation of this protocol. At least the following items should therefore be laid down.

1. date
2. who is responsible for the carry-over inspection
3. description of the method used
4. a plan of the installation with an indication of
   a. grinding, mixing and press lines which were inspected
   b. the place where the measured substance was added
   c. sampling points
5. the number and size of the samples
6. the sampling time interval
7. analysis results
8. proper calculation of the carry-over
9. any sample pre-handling such as grinding, homogenisation, splitting and/or putting together

[1] *The lower carry-over limit is the carry-over percentage on which, using the method applied, a reliable statement can still be made. If the carry-over percentage is lower than at least the carry-over percentage stated here should be used.*

New measurement substances

New measurement substances will be admitted on the basis of examination where there has been validation with respect to the reference method (Cobalt method). The validation report must contain at least the following elements:

a. Name and address details of the submitter and inspection agency
b. Motivation/problem description
c. Characteristics with respect to the
    1. Animal feed installation to be used (including mixer/press installation/cooler)
    2. The reference measurement substances and the measurement substances to be examined
    3. Sampling plan for the samples to be taken in the various flush batches
    4. Sample preparation in the laboratory
    5. Analysis methods to be used
    6. Statistical methods to be used
d. Analysis results
e. Statistical processing of the analysis results
f. Conclusions
g. References

The report may be submitted for assessment by an expert panel to GMP+ International.

5.3 Process accuracy control procedure with cobalt (reference method)

1. FIELD OF APPLICATION

This testing procedure or method for the determining of the uniformity of meals and grains may be used on the usual premixes and mixes of ground compound feed raw materials in compound feed companies.

The method can also be used to obtain an indication of the carry-over which occurs in compound feed raw materials.

2. DEFINITIONS

Product installation: A product installation is an installation which is suitable for the preparation of compound feeds.

Cobalt mix: Cobalt mix is a mixture of wheat grits and Cobalt chloride hexahydrate in such proportions that the cobalt level in the cobalt mix is a minimum of 5% and a maximum of 6% and is prepared in accordance with the applicable standard working instructions as incorporated in § 17 of this inspection procedure.

3. PRINCIPLE

The control procedure for the determination of the degree of uniformity of meal mixes in the preparation of compound feeds makes use of a cobalt mix which, with respect to its properties, can replace the usual compound feed additives.

The control procedure includes the processing of three batches from the same feed mix. The first batch flushes the production installation and serves to determine the “natural” cobalt level in the feed in question. The cobalt mix (see section 2) is added to the second batch. The cobalt level of samples of meal and grains from the second batch is determined. The third production batch consists of the bare feed without the cobalt mix. The cobalt level of the meal and grain samples from this batch is also determined. This level gives a picture of the carry-over which is taking place in the production installation.

The cobalt content of the samples taken is determined using atomic absorption spectrometry (AAS) after heat destruction of the analysis sample at 550 degrees Celsius.

4. EQUIPMENT AND TOOLS

The following are required for the carrying out of the control procedure:

a. 110 plastic pots with lids with a size of 500 ml for saving the samples of meal and grains
b. a plastic scoop for taking the samples.

The number of pots specified is required if samples of meal are taken at one point in the production installation and samples of grains are taken at another point. For each extra sampling point 48 pots of 500 ml extra are needed.
There must be a laboratory which is able to determine cobalt level using atomic absorption spectrometry. Appointments should be made in good time with this laboratory for analyses to be carried soon after the samples are taken.

5. COMPANY DETAILS REQUIRED

The following will be requested in advance from a compound feed company at which a control procedure is to be carried out:

a. a block diagram of the production installation in which it can be indicated during the implementation where the cobalt mix has been added and where samples are taken.

The following will be requested during the implementation of the control procedure:

b. the computer prints or copies of them which show:
   1. the composition of the feed mix
   2. the batch weight requested by the computer, and
   3. the actual batch weight

or, if there is no computerisation:
   1. the composition of the feed mix
   2. the calculated batch weight from the sum of the quantities weighed per component
   3. the read-out of the actual batch weight.

The following will be requested to be able to calculate the batch weight for the mixer and the grain press:

c. where and how much molasses, vinasse and other liquid ingredients added to the main flow of the feed, and
d. where and how much fats, etc., are added to the main flow. The requested addition points are shown in the block diagram.

6. ADDITION OF THE COBALT MIX

A cobalt mix (see section 2) is added to the second batch of compound feed with a nominal cobalt level of at least 5% and maximum 6%.

The place where the cobalt mix is added depends on the carry-over path to be measured (see section 7.1). The place selected for the addition and for sampling should be shown in the block diagram for the product installation.
Add as much cobalt mix as corresponds to a dosage of 2.0 kg per ton of compound feed. The batch weight requested by the process computer may be assumed.

7. TAKING AND HANDLING SAMPLES

7.1 Company samples

7.1.1 Taking the samples

During the implementation of the control procedure in a compound feed company samples are taken at locations agreed in advance:
a. after the mixer but as close as possible to the mixer (see 13.1)
b. from the entrance to the finished product silo in the event of meal production or a pressed meal silo
c. from the entrance to the finished product silo in the event of grain production
d. another desired end point for the determination of the relevant carry-over path

If the meal or grain flow is not reachable at the desired locations then suitable openings should be made in consultation with the company.

Meal production
From the first batch only samples of meal immediately after the mixer are taken these being 10 samples for cobalt determination and another 4 samples for a fluid determination.

From the second batch 20 samples of meal (immediately after the mixer) and 20 samples of meal of 500 ml (from the input to the finished product silo) and 4 samples of meal (input to the finished product cell) are taken for the determination of fluid.

From the third batch 20 samples of meal (immediately after the mixer) and 20 samples of grains of 500 ml (from the input of the finished product cell) are taken for cobalt determination and another 4 samples of meal (after the mixer) and 4 samples of grains (input to the finished product cell) for the determination of fluid.

Grain production
From the first batch only samples of meal immediately after the mixer are taken these being 10 samples for cobalt determination and another 4 samples for a fluid determination.

From the second batch 20 samples of meal (immediately after the mixer) and 20 samples of grains of 500 ml (from the input of the finished product cell) are taken for cobalt determination and another 4 samples of meal (immediately after the mixer) and 4 samples of grains (input to the finished product cell) for the determination of fluid.

From the third batch 20 samples of meal (immediately after the mixer) and 20 samples of grains of 500 ml (from the input of the finished product cell) are taken for cobalt determination and another 4 samples of meal (immediately after the mixer) and 4 samples of grains (from the finished product cell) for the determination of fluid.

If a split is desired with respect to the carry-over by the dosage/grinding/mixing line on the one hand and the press line on the other hand then during the second and third batches another 20 samples of meal for cobalt determination and 4 samples of meal for fluid determination should be taken at the input to the pressed meal silo. The method of working is identical to the method for meal production.

Sample pots
All sample pots are provided with a sample code before the start of the production of the first batch of feed. Once the meal and/or grains flow starts for the batch to be inspected then 20 samples of meal and 20 samples of grains of 500ml are taken spread as well as possible over the duration of the batch. The sample pots must be filled up to the edge to avoid de-mixing (in the case of meal samples) as much as possible.

N. B.: It is very important that the samples are taken spread as well as possible over the duration of the batch in connection with the samples being representative of the batch as a whole.

7.1.2 Sample handling
Each meal and grain sample is ground in a suitable grinder. 90% of the result must pass through a 1.00 mm sieve and 50% must pass through a 0.50 mm sieve. Use sieves with round holes. Do not grind the samples finer than is necessary in order to avoid as much as possible the grinder heating up.

First grind the meal and grains samples from the first batch and then those from the third batch (carry-over batch) and finally the second batch of feed. In this way the samples are ground in ascending sequence of their cobalt level.

Clean the grinder after each sample using compressed air.

Clean the grinder after each group of 24 samples using both compressed air and, after disassembly of the relevant parts, by brushing clean with a brush which is not too soft. There may be no carry-over of material from the previous group of samples.

Homogenise each grinding as much as possible and then place it back in the original pot.

7.1.3 Storage of company samples
Company samples which are not inspected within a week of being taken should be stored in a refrigerated area.

7.2 Analysis of samples
The samples to be inspected which have been stored in a refrigerated area should be transferred at least 16 hours before the start of the inspection to the place where the inspection will take place. The sample packaging may not be opened during this period (see section 13.2). Act as indicated below once the specified period has elapsed.

Homogenise the mix to be inspected in the sample pot as much as possible by stirring it with a spoon or spatula.

From the company sample take 2 analysis samples of the desired amount.
Carry out the cobalt determination for both of the samples.

8. DETERMINATION OF THE FLUID LEVEL

The operational sample taken for the determination of fluid level is used for two analysis samples.

9. DETERMINATION OF THE COBALT LEVEL

9.1 Principle of cobalt determination
The determination of the cobalt level is done with the help of atomic absorption spectrometry (AAS) after heat destruction of the analysis sample measured by a filter of 240.7 nanometers after injection of this solution into the flame of the equipment.

A calibration graph can be made with the help of previously made solutions with an accurately known cobalt content. The extinctions measured in the analysis samples are converted into cobalt levels. The cobalt levels are expressed in parts per million (ppm).

The cobalt contents assigned to the analysis samples are corrected for the “natural” cobalt content determined in the samples of meal from the first production batch.

9.2 Standard samples
In the working instruction for the carrying out of the cobalt determination using atomic absorption spectrometry includes the inclusion of standard samples with a known cobalt content in each series of analysis samples. These standard samples serve as a check on the measured cobalt level.

9.3 Non-standard results
If the cobalt level of two analysis samples from the company sample deviates by more than 5% of the average measured values then two new analysis samples should be taken from the company sample and inspected (see 13.3).

10. PROCESSING OF THE RESULTS

10.1 Non-standard results
The results of the cobalt determinations in the compound feed from the three production batches will be assessed for deviations in as far as these are company samples of which more than two determinations have been done. In such cases a selection is made from the available results for the sample company sample of the two results with the least differences between them. These two results are then also included in the calculations. This avoids an analysis of variance with unequal degrees of freedom having to be carried out.

After the addition of the cobalt mix to the feed in the second batch the cobalt level in the first samples to be taken will be lower than in the subsequent samples [2]. This is because of a degree of carry-over from a bare floor from the first to the second batch of feed.

This may not be neglected in the determination of uniformity of the feed from the second batch. Although not statistically exact, the cobalt levels of the samples from the second batch are not assessed for a non-standard, average level of the results but they are all used for the calculation of the empiric coefficient of variation of the uniformity. That which was stated in the first sentence of this section does, however, continue to apply. The fact that the spread of the average results for the twenty samples is not “normal” but somewhat distorted is ignored.

An opposite effect is seen in the samples from the third batch of feed. Now the samples show a relatively high cobalt level as a result of carry-over of feed containing cobalt from the second to the third batch [2]. Normally the spread of the cobalt levels in the samples from the third batch is considerably more distorted than in the second batch. It is for this reason that the results of cobalt level determination in samples from the third batch are not checked for deviations. There is also no calculation of an empiric coefficient of variation for uniformity and it is enough to make a graph of the average cobalt level per sample against the sample number. In as far as the samples are properly representative for the whole batch which means they have been properly spread over the total duration, the average carry-over of cobalt can be calculated either in absolute terms or as a percentage of the level in batch two.

10.2 Conversion on the dry substance

The measured cobalt contents apply for the analysis samples or the operational samples with the existing fluid content (product basis). In order to be able to work further with the cobalt levels they should all be related to the dry substance.

Use the following formula for this conversion:

$$C = \frac{100}{100 - V} \times C1$$

Where

C	=	the cobalt content on the basis of dry substance in ppm
V	=	the fluid level of the group of operational samples involved in %
C1	=	the measured cobalt level on product basis in ppm.

The measured cobalt levels for dry substance will be decreased by the “natural” cobalt level for dry substance in the bare floor from the first batch.
The cobalt levels corrected in this way for dry substance will be used for the further processing of the results.

10.3 The carry-over

The carry-over for the installation is calculated as follows in accordance with this control procedure per measurement point.
The average cobalt level for dry substance in the group of company samples from the third batch divided by the average cobalt level for dry substance in the group of company samples from the second batch. By multiplying this figure by 100 the average carry-over percentage can be calculated.

10.4 The analysis of variance

The measured, corrected cobalt levels on the basis of dry substance from the samples in the second batch are used as elements in an analysis of variance. The results for meal and for grains are analysed separately.

In this analysis of variance the following sources of variation are distinguished:

a. the differences between the repetitions within the company samples, and
b. the differences between the sample averages from one group of company samples.

The results of the variation analysis are:
a. the standard deviation between repetitions (or within samples)
b. the standard deviation between sample averages (or between samples)
c. the average cobalt level per analysis sample
d. the average cobalt level per group of operational samples
e. the number of degrees of freedom associated with each of the standard deviations

The calculated standard deviations are converted to empiric coefficients of variation by multiplying the standard deviation by 100 and then dividing the product by the average cobalt level of the group of company samples. The empiric coefficient of variation calculated in this way between samples is a measure of the uniformity achieved at the measuring point.

This conversion is necessary because the standard deviation is greatly dependent on the cobalt level in the groups of operational samples.
The arithmetic implementation of the analysis of variance can be found in detail in nearly any manual on mathematical statistics. See, for example, [1].

The cobalt levels of the analysis samples from the third batch are shown in graph form against the number of the sample. These cobalt levels are not suitable for an analysis of variance because they can vary enormously and are usually not spread normally. The average cobalt level in the third batch can be calculated as specified in 10.3.

11. REPORTING

The following is reported for each group of company samples:
a. the average fluid content for the group of company samples (0.01%)
b. the average of the corrected measured cobalt levels on the basis of dry substance from each of the analysis samples (0.1 ppm at cobalt levels higher than 10 ppm and 0.01 ppm at cobalt levels of 10 ppm or less)
c. the average of the corrected measured cobalt levels of the company samples per group (0.1 ppm at cobalt levels higher than 10 ppm and 0.01 ppm at cobalt levels of 10 ppm or less)
d. the calculated carry-over of the installation in accordance with the control procedure.

A report is also made via each group of company samples from the first and second batches of feed of the following:
a. the standard deviations between repetitions (0.0001 ppm)
b. the standard deviation between sample averages (0.0001 ppm)
c. the number of degrees of freedom associated with the standard deviations as intended in 4. and 5.
d. the empiric coefficient of variation between repetitions (0.01 %)
e. the empiric coefficient of variation between sample averages (0.01%)

12. ASSESSMENT OF THE RESULTS

12.1 Repeatability of the cobalt determination

The empiric coefficient of variation between repetitions is a measure of the repeatability of the cobalt determination including sample treatment. The empiric coefficient of variation between repetitions amounts in properly conducted determinations to about 3 - 4% [2]. If the empiric coefficient of variation is greater then the implementation of the cobalt determination should be examined further.

The repeatability (r) is a factor 2.83 higher and therefore roughly amounts to 8.5 – 11.3%. This means that in the implementation of a determination in duplicate by the same analyst with the same equipment, on one in 20 case a difference is found between the two results which is greater than the value given for repeatability (r).

12.2 Uniformity of the material

The empiric coefficient of variation between sample averages is a measure of the uniformity of the meal mix or the grains from which the company samples have been taken. Statistically the group of company samples is not homogenous if the standard deviation between sample averages exceeds the standard deviation between repetitions by more than a given factor (F test). In very small standard deviations between repetitions this leads to a non-uniform mix although there is not yet any reason on technical grounds.

13. REMARKS:

13.1 First sample point

A feed mix is not uniform after the dosage of the various components. Even after the grinding of the raw materials in the hammer mill this is only partly the case. Often finer raw materials are led around the hammer mill and carried straight to the mixer. A uniform feed mix may therefore only be expected for the first time in the mixer. Taking samples directly from the mixer is difficult and may be dangerous and is certainly not recommended. The sample point after the mixer should therefore be used. In most companies this will be the outflow of the bunker under the mixer.

13.2 Acclimatisation of company samples

Company samples which can not be examined in the short term should be stored in a refrigerated area to prevent decay. These samples must be brought to the area where the inspection will actually take place well in advance. This allows the company sample to reach the temperature of the laboratory. This method of working prevents sample material from being exposed to condensation from the warmer air in the laboratory. Condensation makes it impossible to determine the correct fluid content of the sample. A non-homogenous distribution of the condensed fluid in the sample material will also cause a greater spread of the results of the cobalt determination.

13.3 Non-standard results of cobalt determinations

If two cobalt determinations from the analysis samples from the same company sample differ by more than 5% in value then two new analysis samples must be tested.
This procedure usually results in one of the four results being rejected. In addition to company samples with results of two analysis samples there are also samples with three or sometimes four non-deviating results. This makes the implementation of the analysis of variance difficult. Statisticians have developed methods of calculation to replace more than two valid results with two results which contribute in the same way to the variance of the results.

As a judgement on whether or not a mix is uniform rests on a technological agreement on the limit value for the empiric coefficient of variation, it has been decided to simplify the method.

From the set of three or four results of which one (or two) are deviating, the deviating results are rejected.
If three valid results remain then the two results with the least difference between them are used. In this way the variance analysis consists of two company samples each with two repetitions.

14. SAFETY

The control procedure is usually carried out in practice in a compound feed company.

For those who carry out the control procedure in a compound feed company the following safety rules apply:

a. the operatives will make themselves aware before the start of the work of the safety instructions which apply in the compound feed company
b. during their stay in the compound feed company the operatives are bound to follow the safety instructions of the compound feed company
c. during the adding of the premix containing cobalt to the main flow of feed protective gloves and a respiratory protector in the form of a nose covering is to be worn.

15. PROCESSING OF COMPOUND FEED CONTAINING COBALT

The mix containing cobalt is added to the second batch of feed produced for the control procedure at a dosage of 2 kg per ton of feed. The compound feed will then contain about 100 ppm of cobalt. This feed should be stored in a separate cell and may not be traded.
It is recommended that the feed containing cobalt is diluted such that the cobalt concentration in the final feed intended for trading amounts to no more than 2 ppm. Account should be taken when doing this of the cobalt level already present in the raw materials.

The feed from the third batch usually contains only slight amounts of cobalt. As the degree of carry-over is not known in advance, account must be taken of fairly large deviations in the cobalt level of this feed. It is advisable also to store this feed separately and to dilute it sufficiently.

If the compound feed company does not wish to use this feed in any way then it must be treated as chemical waste and handled and removed as such.

16. LITERATURE

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17. STANDARD INSTRUCTION FOR THE PREPARATION OF COBALT MIX

Introduction

The cobalt mix for the carrying out of the control procedure is prepared wet from wheat grits and cobalt chloride hexahydrate. This ensures that the cobalt is well distributed over the cobalt mix and that the cobalt mix does not differ much with respect to its characteristics from the compound feed.

Ingredients

a. wheat grits, well defined quality, as bearer
b. cobalt chloride hexahydrate, minimum 99% pure
c. water of at least mains water quality

Equipment

a. mixing equipment, suitable for dry and wet products, for example the Nauta mixer with clump breaker
b. equipment for spraying under pressure (compressed air)
c. drying equipment with forced ventilation
d. grinding equipment including a high-revolutions grinder
e. sieving equipment.

Safety measures

When working with cobalt, especially when spraying, grinding and sieving, mouth and nose protection should be used and suitable gloves of synthetic material should be worn.

Preparation of the cobalt mix

The required amounts of cobalt chloride hexahydrate and wheat grits are weighed. The cobalt chloride hexahydrate is dissolved in about twice the amount of water. The mix is slightly warmed if necessary (max. 50 ^{o}C) until a clear solution is obtained. The solution is transferred into the pressure vessel of the spraying equipment. The weighed wheat grits are put into the mixer, the mixer is then started and the pressure vessel is put under pressure (c. 2 – 2.5 bar). The supply to the sprayer in the mixer is opened so that the solution is atomised. Once the cobalt chloride hexahydrate solution has been completely atomised, possibly in two or more steps depending on the volume of the pressure vessel, all the equipment which was used three times for the preparation of the cobalt solution and the atomisation must be flushed with a suitable amount of water. The wet cobalt mix is mixed for a further 15 minutes.

After this the mixer is emptied as much as possible and the mixture is dried for 24 hours at c. 60 ^{o}C dried?

The dried material is ground with a high-speed grinder (for example a pin crusher) and then sieved with a mesh of maximum 500 um. The residue from the sieving can be ground again and sieved again with the same sieve.

That which falls through is put together, homogenised in a mixer and hermetically packed, preferably in a quantity which is suitable for immediate use in the testing procedure (i.e. 2 kg/ton).

The packaging states:
a. the name of the product (cobalt mix)
b. filled weight
c. production date and batch and report number
d. the nominal cobalt concentration
e. the sequence number of the packaging in the batch
f. safety measures.

Account must be taken of the fact that the dried cobalt mix is to some extent hygroscopic. It is advisable to work in a dry environment with the least possible exposure to air.

Sampling and reporting
A minimum of four samples are taken from each homogenised batch during the packaging of the cobalt mix. Two of these are intended for a moisture determination and one for the determination of the particle size distribution while at least one is kept as a reserve sample.
The report on the cobalt mix prepared in this way will contain at least:
a. the origin and characterisation of the wheat grits
b. the origin and purity of the cobalt chloride hexahydrate
c. the quantity of carrier, cobalt salt and water used
d. the average moisture content of the mix after homogenisation
e. the calculated cobalt level of the cobalt mix
f. the particle size distribution of the cobalt mix.

5.4 Testing procedure for carry-over in compound feed preparation using cobalt mixes

Note: This method is no longer used. Therefore this section will be removed at the time that all GMP+ documents will be restructured.

This chapter describes a number of alternative procedures for in-company measurement of carry-over using cobalt tracer. These are a simplification of the reference method described in Chapter 2.2

On the one hand it is a procedure in which the number of samples to be taken and analysed can be considerably reduced to that which is strictly necessary for a reliable measurement of carry-over. This particularly limits analysis costs. The company is of course free to take and analyse more samples in order to gain more insight into the process accuracy of the installation.

On the other hand, two procedures are involved in which the cobalt level is lowered by a factor 2 to 4 respectively. This limits the problems of responsible processing of the batch of feed to which the cobalt has been added. It also limits, however, the sensitivity of the method. Very low to relatively low carry-over levels (< 3%, resp. < 5%) are not properly measured with this.

For in-company measurement of carry-over with a reduced cobalt level use may be made of both the reference method specified in chapter 2.2 and the above-mentioned procedure with a reduced number of samples.

For the inspection procedures specified in both chapter 2.3.1 and chapter 2.3.2 a mix based on cobalt sulphate may be used instead of the cobalt mix defined in § 17 in chapter 2.2. The mix on the basis of cobalt sulphate should be prepared in accordance with the standard instructions in chapter 2.3.4.

5.4.1 Modification of the reference method with cobalt for the in-company measurement of carry-over of 1% and more in compound feed mixing (reduced number of samples).

Both the reference method (see chapter 2.2) and this modified procedure can be used to measure a carry-over of 1% or more in the preparation of mixed feeds. Essential in this is the minimum content of 5% cobalt in the cobalt mix to be used and the subsequent content of at least 100 ppm in the feed mix to which the cobalt mix is added.

This description indicates where and in what regard the reference method (chapter 2.2) may be modified for in-company measurement of carry-over. For the sake of simplicity the numbering of chapter 2.2 will be used. Parts of the reference method which are not mentioned remain unchanged in theory or only subject to minor, obvious amendments.

1. FIELD OF APPLICATION

This method is only intended for in-company measurement of carry-over.

2. EQUIPMENT AND TOOLS

At least 46 plastic pots of 50 ml with a lid or plastic sample bags of 1 litre are required.

3. TAKING AND HANDLING SAMPLES

3.1 Taking samples

The following schedule can be used when taking samples in which part of the sampling and/or further handling is voluntary if it is desired to obtain more insight.

a. After the first batch (without added cobalt):
   1. at least 4 samples at the selected control point for carry-over. Preferably after the cooler for the determination of the natural cobalt level in the feed(KAC1 – KAC4)
   2. at least 4 samples at the same control point for the determination of the moisture level (VAC1 – VAC4).

b. After the second batch (with added cobalt mix):
   1. at least 10 samples, as close as possible after the mixer and regularly distributed over the outflow of a batch for the determination of the average cobalt level (KBM1 – KBM10). Possibly (this is voluntary) 20 samples may be taken (see section 7.2.3)
   2. at least 4 samples at the same point for the determination of the moisture level (VBM1 – VBM4)
   3. possibly (this is voluntary) 10 samples at the specified control point(s) for carry-over for the determination of the average cobalt level (KBC1 – KBC10).

c. After the third batch (carry-over batch)
   1. possibly (this is voluntary) 10 samples as close as possible after the mixer, regularly distributed over the outflow of a batch (KCM1 – KCM10)
   2. 20 samples at the specified control point(s) for carry-over, regularly distributed over the total duration of the batch at this point for the determination of the degree of carry-over (KCC1 – KCC20)
   3. at least 4 samples at the same point for the determination of the moisture level (VCC1 – VCC4).

3.2 Sample handling and destination

The technical sample handling (grinding, sequence, etc.) remains as described in chapter 2.2. The following applies with respect to the destination of the samples.

a. All moisture samples have the function that the results of the cobalt analyses for differences in moisture content may be corrected or recalculated for dry substance.

b. The samples KAC1 – KAC4 are analysed individually in duplicate. This is – especially for the third batch – of great importance because the cobalt levels in batches two and three must be corrected for the “natural” cobalt level in the feed.

c. Samples KBM1 – KBM10 can serve two purposes. Each sample can if desired be split into a ‘a’ and a ‘b’ sample, or, if 20 samples are taken instead of 10 (see section 7.1.2), these can be used in turn or each can be split for one purpose or another.
d. Possibly (this is voluntary), one half of the samples can now be used to determine the uniformity of the mix. To do this the 10 (or 20) samples must each be analysed separately in duplicate.

e. A mix can be made of the other half of the 10 or 20 samples possibly after further reduction of the product which is used to determine the average cobalt level of the second batch. To do this at least two new samples are taken from the mix in which the cobalt level and the moisture level are analysed in duplicate. Naturally, the average cobalt level of batch two may also be determined by averaging the individual duplicate results of the 10 or 20 samples.

f. Using samples KBC1 – KBC190 an impression can be obtained (this is voluntary) of the extent to which the uniformity obtained immediately after mixing (KBM1 – KBM10) in the subsequent production and transport process is maintained up to the control point for carry-over. These samples must each be separately analysed in duplicate.

g. Using samples KCM1 – KCM10 a determination may possibly be made (this is voluntary) the extent to which carry-over is already occurring in the path up to the sampling point immediately after the mixer. For the analysis a choice can be made to analyse a mix sample (analysis of two samples in duplicate for the average carry-over), or of all ten samples separately in duplicate (carry-over pattern and calculation of the average).

h. The samples KCC1 – KCC20 may be mixed two at a time, thus KCC1 + 2, KCC3 + 4 etc., after which in each of the 10 new samples in duplicate the cobalt level is determined. Assuming that each of the original samples is representative for an equivalent part of the batch, the average carry-over can be directly calculated. If it is known that this is not the case, for example because of irregular time intervals between sampling, the weighted average, related to the actual time intervals, is calculated.

i. It may also be decided to analyse each of the samples KCC1 – KCC separately and then to calculate the average as described above.

4. PROCESSING OF THE RESULTS

4.1 Variance analysis

In this simplified implementation the results are only suitable to a limited extent for statistical analysis.
In as far as there are measurement series with analyses carried out in duplicate, it is advisable in any event to calculate via a variation analysis the empiric coefficient of variation between repetitions per measurement series.
In as far as there are measurement series for which in an ideal case the results must have the same value (uniformity), an analysis of variance must be carried out with which both the empiric coefficients of variation between samples as well as between repetitions is calculated.

This applies in particular to the sample series KAC1, KAC4 and possibly for KBM1 – KBM10, KCB1 – KBC10 and KCM1 – KCM10 in as far as one takes samples from these series, individually analyses them and is interested in the degree of uniformity.

4.2 Calculation of carry-over

All cobalt levels are corrected in advance using the average results of the corresponding moisture determinations for dry substance. The carry-over for the installation is now calculated as follows on the basis of the corrected values:
the average cobalt level in the 20 samples KCC from the third batch minus the average cobalt level in the 4 samples KAC from the first batch, divided by the average cobalt level from the 10 samples KBM from the second batch, also minus the average cobalt level in the 4 samples KAC from the first batch. By multiplying the result by 100 an average percentage carry-over in the batch immediately following the batch to which the cobalt mix was added as a model for a premix with additive can be calculated.

By displaying the results of the cobalt analyses in the samples KCC1 – KCC20 (corrected for the average of KAC1 – KAC4) in graphic form, a carry-over pattern is obtained which gives in principle more information than the calculated average.

4.2.1 Modification of the measurement methods with cobalt for the in-company measurement of carry-over of 3% and more in compound feed mixing

For the in-company measurement of carry-over of 3% or more, either the testing procedure described in chapter 2.2 or the modified procedure described in chapter 2.3.1 is used. Use is made of a cobalt content in the cobalt mix as specified in section 2 of chapter 2.2 of minimum 2.5%. This realises a level of about 50 mg/kg in the second batch of feed in the testing procedure.

4.2.2 Modification of the measurement methods with cobalt for the in-company measurement of carry-over of 5% and more in compound feed handling

For the in-company measurement of carry-over of 5% or more, either the testing procedure described in chapter 2.2 or the modified procedure described above in chapter 2.3.1 is used. Use is made of a cobalt content in the cobalt mix as specified in section 2 of chapter 2.2 of minimum 1.25%. This realises a level of about 25 mg/kg in the second batch of feed in the testing procedure.

Literature

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4.2.3 Standard instruction for the preparation of a cobalt sulphate mix for the in-company measurement of carry-over

Introduction
The cobalt mix for the carrying out of the testing procedure is prepared via dry mixing from wheat grits, wheat red dog and cobalt sulphate. This ensures that the cobalt is well distributed over the cobalt mix and that the cobalt mix does not differ much with respect to its characteristics from the compound feed.

Ingredients
a. wheat grits and wheat red dog, well defined quality, as bearer
b. cobalt sulphate heptahydrate, minimum 98% pure

Equipment
mixing equipment, suitable for dry products, such as Planet mixer.
Also needed as tools are, among others, suitable balances for weighing the ingredients.

Safety measures
When working with cobalt, mouth and nose protection should be used and suitable gloves of synthetic material should be worn.

Preparation of the cobalt mix
The required amounts of cobalt sulphate heptahydrate, wheat grits and wheat red dog are weighed.
The weighed quantities are mixed in a Planet mixer for 15 minutes. The mix is then measured into buckets of 2.0 kg and properly closed off with a lid.

The packaging states:
a. name and code of the product (cobalt mix)
b. filled weight in kg
c. date of production
d. the nominal cobalt concentration
e. the sequence number of the packaging in the batch
f. safety measures.

The closed buckets should be stored under air-conditioned conditions.
Open the packaging immediately before use.

The cobalt mix should comply with the following requirements:
a. particle size: maximum 1% > 0.7 mm; maximum 10% > 0.5 mm
b. cobalt level: at least 4.5%

Sampling and reporting

Four 4 samples are taken from each homogenised batch during the packaging of the cobalt mix. Of these 1 is intended for moisture determination, 1 for the determination of particle size distribution and 1 for the determination of cobalt, while 1 is kept as a reserve sample.

The report on the cobalt mix prepared in this way will contain at least:

a. the origin and characterisation of the wheat grits
b. the origin and characterisation of the wheat red dog
c. the origin of the cobalt sulphate heptahydrate
d. the amount of carrier and cobalt salt used
e. the moisture content of the mix after homogenisation
f. the calculated cobalt level of the cobalt mix
g. the analysed cobalt level of the cobalt mix
h. the particle size distribution of the cobalt mix.

5.5 Testing procedure for the carry-over in compound feed mixing using a mix of manganate and a protein-rich and a protein-poor mix

1. APPLICATION AREA

The testing procedure was developed for the determination of the carry-over which occurs in compound feed production companies. The carry-over of large components from the batching equipment for raw materials and the carry-over of the components which are added via the premixes are determined separately.
By collecting the samples which have been taken for the carry-over inspection at various different places in the production process, insight can be obtained into the carry-over in components of the production process (for example: grinding / mixing line to pressed meal bunker or the press / cooling line). The method is also suitable for the determination of the extent to which uniform mixes can be produced using the installation (see item 9).

2. DEFINITIONS

Carry-over
Carry-over means that part of the previous batch of feed remains in the production and transport system and gets into the following batches.

Carry-over level
The carry-over level is defined as the amount of a nutrient of component from a previous batch, expressed as a percentage, which gets into the following batch of feed (of the same size). The carry-over level can be measured for a section of the installation (for example the pressed meal bunkers) or for the whole installation.

3. PRINCIPLE OF THE TESTING PROCEDURE

The testing procedure is carried out by first fabricating a protein and Mn-rich Soya mix and immediately afterwards by fabricating a protein and Mn-poor mix on the same production line. The increase in the protein and Mn level of the maize mix during the running of the production line is caused by carry-over. By relating this increase to the protein and Mn level of the Soya mix, the carry-over level can be calculated.
Because the protein and manganese content of the maize mix progresses hyperbolically (from high levels at the beginning of the flow to lower levels afterwards), the sampling procedure must be given particular attention.

4. EQUIPMENT AND TOOLS

The following are required for the carrying out of the testing procedure:
a. a quantity of manganese oxide corresponding to 0.4% of the usual batch size
b. (possibly) a scoop for taking samples
c. two buckets to be able to collect a number of sub-samples
d. sample pots or bags which can hold at least 200 grams of material. If the carry-over inspection is carried out at two places in the production line then 20 sample pots will usually be enough (only 14 samples will actually be tested).

5. COMPANY DETAILS REQUIRED

The following must be known about the company where the testing procedure will be carried out:

a. the block diagram of the production installation
b. the way in which the Soya and maize mix is put together. An exact indication should in particular be given of how and where the manganese oxide is added and how any transport system for the manganese oxide to the mixer is flushed both for the Soya mix and for the maize mix.

6. IMPLEMENTATION OF THE TESTING PROCEDURE

6.1.a. Fabrication of the protein and Mn-rich Soya mix

The Soya mix (with the usual batch size) consists of 92% Soya meal, 4% fat, 3% cane molasses, 0.4% manganese oxide and 0.8% dicalcium phosphate (or chalk or salt). This mixture is batched, ground, mixed and pelletised in the usual way. Molasses and fat are added to obtain a meal with normal physical characteristics which can be pelletised properly. The Soya meal may come from more than one batching silo.
The manganese oxide comes instead of the premix and should take the same route as the premix. The manganese oxide is therefore batched into the premix weighing machine or dumping pit.
The batching should be carried out such that the manganese oxide comes virtually fully to the bottom of the premix weighing machine or dumping pit.

The manganese oxide should comply with the following requirements:

a. Mn level at least 50%
b. particle size: 100% should be smaller than 0.2 mm.

Normally, chalk, salt and/or feed phosphate is batched via the same weighing machine or dump pit. Because of this the carry-over of components from the premix will be less especially when first the premix and only then the other products are batched.
For the testing procedure first 0.4% manganese oxide and then 0.8% chalk, feed phosphate or salt is batched.
Once the content of the premix weighing machine (or the dumping pit) has been added to the Soya mix in the mixer, the normal mixing time is carried out. The mix is then removed to an empty pressed meal bunker and pelleted (sample).
The grinding/mixing line and the press/cooling line may not be used for anything other than the maize mix after the Soya mix.

6.1.b. Sampling of the Soya mix

When unloading the Soya pellets in the finished product silo a good mix sample is taken from the last part of the batch.

6.2.a. Fabrication of the protein and Mn-poor maize mix

The maize mix (with the same batch size as the Soya mix) consists of 92% maize, 4% fat, 3% cane molasses and 0.8% dicalcium phosphate (or chalk or salt). If it is not possible to batch 92% maize then a maize/wheat mix or another protein-poor mix may be put together (sample).
The transport system between the premix weighing machine (or dumping pit) and the mixer is flushed with 0.8% dicalcium phosphate (or salt or chalk).
The mixing time starts once the feed phosphate has been added to the mix. The mix is then removed to the (empty) pressed meal bunker (sample) and then pelletised (sample).

6.2.b. Sampling of the maize mix

The following samples of the maize mix are collected:

a. the maize (and possibly the wheat) which is used for the composition of themix
b. six samples from the maize mix at the inflow to the pressed meal bunker
c. six samples from the maize mix at the inflow to the final product silo.

The sampling procedure is important for the samples in II and III. In particular the first part of the meal or the pellets from the batch will have higher levels of protein and manganese which will then decrease relatively quickly to a lower and more constant level. It is therefore important to sample the first part of the meal or pellet flow intensively and to know to which part of the feed these samples relate.

The sampling procedure at the inflow to the pressed meal bunker (which usually lasts 3 to 5 minutes) is as follows:

a. during the first 30 seconds as many sub-samples as possible are collected in a bucket; a mix sample is made from these
b. for the second 30 seconds: idem
c. then every 30 seconds a random sample from the flow is collected until the meal flow stops.

The total running time of the meal flow is noted and 6 samples are kept, namely the three which were taken first and three of the other samples.

The sampling of the pellets at the inflow to the finished product silo takes place in the same way. Because the total duration is usually somewhat longer the procedure is now as follows:

a. during the first minute as many sub-samples as possible are collected in a bucket; a mix sample is made from these
b. during the second minute: idem
c. then every minute a random sample from the flow is collected until the pellet flow stops.
d. (If the pellet flow is not continuous then the “real” duration should be used.)

Note the total duration here as well and keep six samples, namely the three which were taken first and three of the other samples.

6.3 Processing of the Soya mix in compound feed

At low carry-over levels the Soya mix has a Mn level of c. 2,000 mg/kg. In the processing of this Soya mix in compound feed account should be taken of the fact that the Mn level of compound feed may be a maximum of 250 mg/kg.

7. THE ANALYSIS OF THE SAMPLES

In total there are 14 (or possibly 15) samples collected:

1 sample of Soya pellets (+ Mn)	= A
1 sample of maize (pure) (+ possible wheat)	= B
6 samples of maize mix meal (pressed meal bunker)	= C (1 to 6)
6 samples of maize mix meal (finished product silo)	= D (1 to 6)

All samples are analysed for RE and Mn.
Half of the samples of maize meal mix and maize mix pellets are analysed for moisture; this is in order to find out whether the moisture content has changed during pelletising. If the moisture content has clearly changed during pelletising then the RE and Mn levels of the maize mix pellets should be corrected for the moisture content of the maize mix meal.

8. THE CALCULATION OF THE CARRY-OVER PERCENTAGES

The carry-over percentages can be calculated from the levels of RE and Mn in the samples taken. Suppose that the following levels are found:
Soya pellets: 420 grams RE and 2,006 mg Mn/kg
Pure maize: 86 grams RE and 4 mg Mn/kg
samples maize mix (above the pressed meal bunker)

1.	mix sample (0.5 min.)	160 grams RE	and	400 mg Mn/kg
2.	mix sample (0.5 min.)	100 grams RE	and	60 mg Mn/kg
3.	random sample	90 gram	and	27 mg
4.	random sample	85 grams (avg. 88)	and	30 mg (avg. 28)
5.	random sample	88 gram	and	28 mg
6.	random sample	89 gram	and	27 mg

The total duration of the meal flow in the pressed meal bunker = 5.5 min.

Expected levels of maize mix (92% maize and 3% molasses with 40 grams RE and 25 mg Mn/kg):

RE	=	0,92* 86 + 0,03*	40 =	80,3	gram/kg
Mn	=	0,92* 4 + 0,03*	25 =	4,4	mg /kg

The average levels of RE and Mn in the maize mix are calculated as follows:

RE	=	0,5/5,5* 160 + 0,5/5,5*	100 + 4,5/5,5*	88	=95.6 grams/kg
Mn	=	0,5/5,5* 400 + 0,5/5,5*	60 + 4,5/5,5*	28	= 64.7 mg/kg

(samples 1 and 2 each have a duration of 0.5 minutes from a total duration of 5.5 minutes.
For samples 3 to 6 the average level is calculated; the duration of this is 5.5 – 2 x 0.5 = 4.5 minutes).

The carry-over percentage (Vs-%) is now calculated as follows:

$$Vs\text{-}\% = \frac{\text{avg. level in maize mix} - \text{expected level in maize mix}}{\text{avg. level in Soya pellets} - \text{expected level in maize mix}} \times 100$$

The carry-over percentages are then (up to the pressed meal bunker)

$$\text{for RE} = \frac{95{,}6 - 80{,}3}{420 - 80{,}3} \times 100 = \frac{1.530}{339{,}7} = 4.5\%$$

$$\text{and for Mn} \frac{64{,}7 - 4{,}4}{2.006 - 4{,}4} \times 100 = \frac{6.030}{2.001{,}6} = 3\%$$

The carry-over percentages at the inflow to the finished product cell are calculated in the same way.
The carry-over percentage of the RE relates to the feed as such, from the batching equipment.
The carry-over percentage for the Mn gives an indication of the carry-over of components from the premix.

9. THE MEASUREMENT OF UNIFORMITY

In order to determine the extent to which the installation produces uniform mixes, at least 10 samples should be collected from the Mn-rich Soya mix and analysed for Mn. The spread of the Mn levels of these samples (standard deviation or the difference between the highest and lowest value) is a measure of uniformity.

When taking the samples from the Soya mix one should ensure that the whole flow of the mix is sampled. Because it is often not known exactly how long the meal flow will last, it is desirable in the first instance to take a generous number of samples of which only a part (namely 10) need to be tested.

The uniformity test may be carried out at many places in the installation. If the samples are taken immediately after the mixer then a good picture is obtained of the functioning of the mixer.
If, on the other hand, samples are taken at other places in the installation (but after the mixer) then the uniformity will generally be less than immediately after the mixer.

This is because in this case de-mixing and carry over also play a role. Because the Mn-rich Soya mix is always produced after a “normal” compound feed with much lower Mn levels, the first samples of the Soya mix will be contaminated with a certain amount of compound feed and will therefore contain less Mn. The subsequent samples will be contaminated with less and less normal compound feed and will have higher and higher Mn levels.

10. ERRORS DISCUSSION

Table 1 shows which Mn and protein levels are to be expected in the maize mix at the various carry-over percentages, assuming 80 grams RE and 5 mg Mn/kg maize mix (pure) and 400 gram RE and 1,800 mg Mn/kg Soya mix.

Table 1 Effect of carry-over percentage on Mn and protein level of the maize mix.						
Carry-over %	0	1	3	5	10	15
MN from basis*	5	5	5	5	5	5
From Soya	0	18	54	92	180	270
	5	23	59	95	185	275
* effect of thinning discounted						
RE from basis	80	79,2	77,6	76	72	68
From Soya	0	4	12	20	40	60
	80	83,2	89,6	96	112	128

On the basis of the analysis accuracy of the Mn and RE determination an estimate can be made of the accuracy with which the carry-over percentage can be determined.

For the 6 maize samples to be tested it is assumed that the average Mn-level found in 95% of the cases will lie between 95 and 105% of the actual level; for levels < 60 mg/kg the absolute interval is made equal to the interval for
60 mg/kg, thus +/- 3 mg/kg.
For the Soya mix it is assumed that the Mn level found in the analysis will deviate by a maximum of 100 mg/kg from the actual level.
For the protein it is assumed that the average level found for the 6 maize samples will in 95% of cases lie between 99 and 101% of the actual level and that the level found for the Soya mix will deviate by a maximum of 2% from the actual level.

The results of the calculations are shown in Table 2.
It may be concluded that low carry-over percentages can be determined fairly reliably.
For low carry-over levels Mn seems to comply better than the RE; at high carry-over levels, on the other hand, the protein gives better results than the Mn.

Table 2: Effect of the analysis accuracy on the carry-over percentage to be established				
		Maize mix		
Carry-over level		Calculated	Interval analysis	Carry-over percentage*
Mn	0	5 mg/kg	2 - 8 mg/kg	0,16 - 0,18%
	1	23	20 - 26	0,8 - 1,2
	3	59	56 - 62	2,7 - 3,4
	5	95	90 - 100	4,5 - 5,6
	10	185	176 - 194	9 - 11,1
	15	275	261 - 289	13,5 - 16,7
On the basis of 1800 mg Mn/kg Soya mix (variation 1700-1900, at low Mn in maize there is a calculation of high Mn in Soya, and vice versa).				
		Calculated	Interval analysis	Carry-over %*
RE	0	80 g/kg	79.2 - 80.8 g/kg	- 0,25 - 0,25
	1	83,2	82,4 - 84,0	0,7 - 1,3
	3	89,6	88,7 - 90,5	2,6 - 3,4
	5	96	95,0 - 97,0	4,5 - 5,5
	10	112	110,9 - 113,1	9,4 - 10,6
	15	128	126,7 - 129,3	14,2 - 15,8
On the basis of 400 g RE/kg Soya mix (variation 392-408, at low RE in maize there is a calculation of high RE in Soya, and vice versa).				

5.6 Testing procedure for the measurement of carry-over in premix and additives installations

1. SYSTEM

The method of measurement of carry-over in premix and additives installations corresponds as far as the systematics are concerned to Chapters 2.2 to 2.4.

2. CARRY-OVER PROCESS

a. The carry-over process to be measured relates to the point where the additives and/or animal veterinary products are added to the bulk vehicle load or the bag filling.
b. Measurement of the carry-over should be carried out for each production line in the installation.
c. The measurement should be carried out with a quantity of mix which is equal to the smallest batch which in practice may be produced on the production line in question.

3. TRACER SUBSTANCE TO BE USED

The following tracer substance can be used for the measurement of carry-over: cobalt mixes in accordance with Chapter 2.2 or 2.3.4 with a cobalt concentration of at least 200 mg/kg. At cobalt concentrations of 2,000 mg/kg or more use may also be made of pure cobalt sulphate. In addition the microtracers FSS-Lake and F-Lake and methyl violet can be used in the dosage of 10 mg/kg. Otherwise there should be compliance with Chapter 2.3.4.

4. DETERMINATION OF CARRY-OVER

The measurement of carry-over is done by taking the mix in which the carry-over occurs into consideration as a whole. This means that the average level in this mix is the departure point for determining the carry-over. The carry-over is measured as follows:

a. mix the whole mix again
b. take and analyse 5 samples from this mix (V1 to V6). The average level is calculated from this
c. The carry-over is measured as follows:

$$\frac{\text{(average quantity in mix in which carry-over occurs)}}{\text{(batching in previous mix from which there is carry-over)}} \times 100\%$$

5.7 Checking procedure for the process accuracy of compound feed with micro tracers

1. Field of application

This procedure may be used in the feed production industry for determining the homogeneity in premixtures and compound feed or any other particle mixture. With an appropriate pre-treatment it is also applicable to a wide range of matrices like pelleted feed or extruded feed.

This procedure can also be used to determine the carry-over to subsequent batches.

2. Definitions

Microtracer particles:	Very fine elementary iron particles coated with a non-toxic food colourant (e.g. Microtracer®- Lake particles) The colour is not visible in feed and is treated during analysis to develop the colour.
F particles:	Microtracer particles with a mean of 25.000 particles per gram.
FS particles:	Microtracer particles with a mean of 50.000 particles per gram
FSS particles:	Microtracer particles with a mean of 600.000 particles per gram.
Microtracer premix:	Preparation of Microtracer particles and limestone or other appropriate carriers. It is used to apply the Microtracer to the feed production line in the same way micro-ingredients of the test batch are added in the production plant. Each Microtracer premix comes from the producer with a certificate of analysis.
Rotary Detector:	Rotating permanent magnetic tool used to quantitatively separate small magnetic particles.

3. Principle

Two subsequent batches have to be tested to check homogeneity and carry-over. Microtracers are added to the first batch only. They are added to the feed production line like other micro-ingredients. The usual feed composition and production procedure don´t have to be modified for the test. Care has to be taken that no additional Microtracer (e.g. for marking) is contained in the added premixture. To determine homogeneity samples are taken directly after the mixer and from each type final feed (e.g. meal and/or pellets) at the end of the production line. For carry-over measurements samples are taken from the second feed batch to which no Microtracer has been added. The samples are analysed for Microtracer content by separating the magnetic particles with a rotating permanent magnetic tool, the rotary detector. To distinguish between Microtracers and other magnetic particles the colour of the Microtracer particles is made visible and countable using chromatography. The number of Microtracer particles monitors directly the quality of the mixing and the amount of carry-over, respectively. Both batches can be used as feed because Microtracer particles are non-toxic and do not colour the feed.

Extra clarification: Even strong magnets do not necessarily have to be turned off for testing as they may lower the recovery rate but do not influence the distribution of the Microtracer.

4. Company details required

The following information will be requested in advance:

- a block diagram of the production installation to note where the Microtracer premix is added and where the samples are taken
- expected batch size
- appropriate carrier for preparation of Microtracer premix

The following information will be requested during sampling:

- computer prints or copies which show:
  - the composition of the feed mix
  - the batch size requested by the computer
  - the actual batch size according to the batch protocol
- or, if there is no computer:
  - the name and article number of the feed mix
  - the calculated batch size (obtained by adding the weight of all components)
  - the read-out of the actual batch size.

The following information will be requested to be able to calculate the batch size for the mixer and the batch size of the final product.

- weight and addition point of liquid ingredients (molasse, vinasse etc.)
- weight and addition point of fats etc.
- the addition points have to be noted in the block diagram

5. Planning of the test

Before sampling the test has to be planned in detail. In case of small batch sizes (below 100 kg) the pure Microtracer FSS can be added, in case of bigger batch sizes it is added as a premix. The concentration and amount of Microtracer premix have to be chosen to allow later during analysis to count 100 - 200 particles per sample on one filterpaper. For the preparation of the premix the following calculations are necessary:

5.1 Homogeneity (batch 1)

Dosing of the Microtracer particles:

Information required:

- accuracy to be checked (e.g. 1:100 000)
- size of Microtracer premix $[g]$
- batch size of the test mix$[g]$
- number of Microtracer particles per gram (from certificate of analysis)

Calculations:

a. Weight of pure Microtracer to be added:
   batch size × accuracy = weight of Microtracer $[g]$ to be incorporated in Microtracer premix. The complete Microtracer premix is added to the first batch. (A small amount is kept for analysis when preparing the premix.)

b. The total number of added Microtracer particles is calculated:
weight of Microtracer $[g]$ × number of Microtracer particles per gram = number of Microtracer particles added
c. theoretical concentration of Microtracer particles in feed of first batch:
number of particles added / batch size = amount of Microtracer particles per gram feed

Example:
- accuracy to be checked: 1: 100 000
- weight of added Microtracer premix: 4000 g
- batch size of the test mix 1000 kg = 1 000 000 g
- Microtracer FSS has about 600 000 particles per gram

Calculations:
a. Microtracer weight to be added: 1 000 000 g × 1:100 000 = 10 g.
A Microtracer premix is prepared with 10 g Microtracer FSS and 3990 g limestone (or a different suitable carrier).
b. Total number of particles: 10 × 600 000 = 6.000.000 particles. The complete Microtracer premix is added to the first 1000 kg test batch in the feed production.
c. theoretical concentration in first batch: 6 000 000 / 1 000 000 g = 6 particles per gram feed.

Sample size for Microtracer analysis:
The sample size for each Microtracer analysis is chosen to yield 100 – 200 particles per filterpaper.

Example:
In the given example samples of 20 g should contain 20 g × 6 particles per g =120 particles which can be counted easily on one filterpaper.

Sampling from the production line:
To determine homogeneity, samples from batch 1 are taken directly after the mixer or if technically impossible directly from the mixer and from each type final feed at the end of the production line. At each sampling place ca. 20 samples (e.g. after the mixer HM1 – HM20 and from the final product HF1 – HF20) are taken spread as well as possible over the duration of the batch.
The sample size should allow analysing each sample at least three-times. Usually a 100 g sample will be sufficient.

5.2 Carry-over (batch 2)
No addition of Microtracer particles:
To check the carry-over no Microtracer particles are added to the second, subsequent batch. This batch should follow the very same way through the production line (e.g. same silos, same transportation belts) as batch 1 of homogeneity. The carry-over level of Microtracer particles from the first batch is measured.

Sample size for Microtracer analysis:
Usually very low amounts of Microtracer particles are expected. About 400 – 1000 g of each sample is analysed. As the highest carry-over is expected in the first three samples about half of the sample weight is analysed for samples C 1 – C 3 (see section 9).

Sampling from the production line:
Ca. 20 samples (C1 – C20) are taken from each type final feed at the end of the production line evenly spread over the whole flow-time. The carry-over is expected to be higher in the first samples and very low in the end. Usually a sample size of 400 – 1000g is sufficient.

5.3 Further sampling places

If further sampling places are requested, sampling should be planned according to the purpose of the measurement in line with the principles laid down under 5.1 and 5.2.

Tracer and concentration	Size of sample for homo-geneity (from batch 1)	Size of sample for carry-over (from batch 2)
FSS 10 ppm	ca. 100g	ca. 400-1000g
FS 100 ppm	ca. 100g	ca. 400-1000g
F 100 ppm	ca. 100g	ca. 400-1000g

6. Equipment and tools

To take samples at the production plant the following is needed:

- for homogeneity testing: ca. 40 small plastic sampling bags (200 ml), provided with a sample code
- for carry-over testing: ca. 20 large plastic bags (2000 ml), provided with a sample code
- for each extra sampling place: ca. 20 plastic bags (volume depends on expected Microtracer concentration), provided with a sample code
- adequate sampling tools (e.g. small and large scoop for taking the samples in the bags)

To analyse the Microtracer content:

- see section 9

7. Sampling from the production line

The Microtracer premix is obtained in the concentration planned in section 5 and added to the mixer in the same way micro-ingredients are added during the production process (e.g. microdosing silo, directly into the mixer, or via handtipping into the mixer). Samples are taken as planned (see section 5) and stored almost air-tight in sampling bags. Sampling has to be recorded in a sampling protocol, comprising:

- date of sampling
- name of person who does the sampling
- batch details (see section 5)
- number of samples
- place, where samples are taken
- sample codes
- any other relevant information

Samples are stored dry at room temperature (if there are no special requirements) and transferred to the laboratory in due time.

8. Preparation of samples

If the samples taken are not in meal form (e.g. pelleted or extruded feed) the samples have to be ground in a suitable grinder (e.g. Retsch mill, 1mm sieve).

The samples have to be ground in order of increasing expected Microtracer content, i.e. starting with the last samples of batch 2. In batch 1 the sequence of grinding is not crucial, because all samples should contain the same amount of Microtracer particles.

Clean the grinder thoroughly after each sample: use compressed air, disassemble relevant parts, sweep with a brush or a handbroom and/or use a vacuum cleaner. No carry-over of material from previous samples is allowed.

9. Determination of Microtracer particles

Equipment:
Rotary Detector
Demagnetizing equipment
Gloves
Paper and pencil
Appropriate vessel and tablespoon for weighing
Scale
Small filter paper, diameter: 70 mm
Large filter paper, diameter: 180 mm or bigger e.g. DIN A4
fan brush
Basin for developing solution
appropriate absorptive paper
tweezers
Heating plate (110°C)

Chemicals:
developing solution: 7 % sodium carbonate solution.

Sequence of the analysis:
In the laboratory the samples are analysed in the order of expected increasing number of Microtracer particles, i.e. from C20 to C1 and from H1 to H20 (the order is not relevant here).

Sample amount for assay:

1. carry-over:
   For the analysis of carry-over the sample amount analysed should be about 400 g to 1000 g. The lower the expected carry-over level is, the higher the sample amount should be.
   Example: About 800 g to 1000 g samples should be analysed for an expected carry-over level below 1 %. To find the right sample weight analyse 500 g of a sample from the middle of the feed flow (e.g. sample C10). Count the particles and adapt the weight, so that if possible in minimum 30 particles are counted. If necessary, weigh less (may be half, i.e. 250 g) for the first three samples with the highest expected carry-over, because the particle count should not exceed 200 particles per filter. For installations with a very low expected carry-over the particle count per sample may be below 30.

2. homogeneity:
   The sample amount has been estimated in section 4. To check if this is the right sample weight, analyse 20 g of a sample from the middle of the feed flow (e.g. sample H10). Count the particles and adapt the weight, so that 100 - 200 particles per filter are counted. Analyse approximately this weight for all samples from the homogeneity batch. Do not weigh exactly this weight, generally weigh two tablespoons and note the exact weight.

Execution of the analysis:

- gloves should be used during analysis.
- Place a small filter paper on the magnet in the Rotary Detector and replace the top hopper.
- Weigh the amount of sample to be assayed. Note the weight.
- Turn on the Rotary Detector (normal operation, see instruction manual Rotary Detector).
- Transfer the sample completely into the Rotary Detector using a clean brush.
- Remove the top hopper of the Rotary Detector (Auto-stop operation: the rotating magnet stops automatically)
- Turn on the Rotary Detector for the so-called “brushing mode” (the Rotary Detector works for 5 s and then stops automatically again). Within these 5 seconds clean the small filter paper and the edge of the fixation ring from light substances of the feed (mainly fine dust particles), using a brush.
- Wet the large filter paper completely in the developing solution basin, put the filter paper on a clean smooth work surface and absorb excess developing solution with paper
- Remove the fixation ring from the magnet and carefully transfer the small filter paper straight upwards from the rotary magnet without losing Microtracer particles
- Demagnetize the Microtracer particles on the small filter paper: hold the small filter paper above the demagnetizer at a distance of about 1 cm, turn on the demagnetizer with the other hand, move the small filter paper straight upwards without turning off the demagnetizer, afterwards turn off the demagnetizer
- Transfer the small filter paper horizontally above the large filter paper
- Sprinkle the Microtracer particles from the small filter paper to the large filter paper, so that all particles lie separate: for this purpose touch the Microtracer particles on the small filter paper with one finger and move the small filter paper slowly above the large filter paper to spread the particles over the large filter paper with this finger. Turn the small filter paper and tap the back side of the small filter paper to remove all particles from the filter. Tap your finger once to the edge of the large filter paper to remove particles in case they may have been attached to your finger.

- After about 10 s transfer the large filter paper to the heating plate, the colour development of the Microtracer particles is stopped by the heat.
- Take the large filter paper off the heating plate with tweezers when it is dry.
- Label the large filter paper with a pencil.

Note: Clean the workplace dry after each sample.

10. Evaluation

Each Microtracer particle is developed to a colour dot on the large filterpaper. The number of colour dots equals the number of particles. The dots are counted by eye or with an appropriate computer aided system (e.g. TraCo image assessment and evaluation system).

To yield correct results the statistical evaluation is done in accordance with the Poisson distribution.

1. Evaluation of homogeneity

The following statistical data are relevant:

- Number of analysed samples (=n)
- Mean number of Microtracer particles in batch 1 (=X_m)
- Number of Microtracer particles in different samples, corrected for 20g sample size (=X_n)
- Number of degrees of freedom of the system (= n – 1)
- The sum of the squares of the difference between the number of Microtracer particles in different samples (X_n), and the mean number of Microtracer particles in batch 1 (X_m) gives S.
  $S=\sum(X_n - X_m)^2$.
- Chi squared value (=S/X_m)
- The probability p in % can be calculated from chi squared and the number of degrees of freedom e.g. with Excel using the CHIVERT function.
  p in % = CHIVERT(chi squared;number of degrees of freedom) × 100
- Microtracer recovery in %
  recovery in % = X_m × 100 / number of Microtracer particles added to batch 1

Using the probability p in %, the assessment of the homogeneity is defined as follows:

- if p ≥ 25 % it can be conducted that the mixture is excellent. The closer the p value is to 100 % the better the mixture is.
- if 5% ≤ p < 25 % it can be conducted that the mixture is good.
- if 1 % ≤ p < 5 % no clear statistical conclusion can be made. It is recommended to repeat the test.
- if p < 1 % it can be concluded that the mixture is non-homogeneous.

The Microtracer recovery should be 100 % ± 15 %. Reasons for a low recovery rate are usually found in the production installation, i.e. if not all of the Microtracer premix did reach the mixer or strong external magnets take out a minor portion of the Microtracer (this does not influence the test result).

Example1: Homogeneous mix

Sample number n	Corrected number of particles counted X_n	Difference $X_n - X_m$	Square of difference $(X_n - X_m)^2$
1	100	-13	169
2	100	-13	169
3	124	11	121
4	123	10	100
5	104	-9	81
6	121	8	64
7	119	6	36
8	103	-10	100
9	117	4	16
10	115	2	4
	Mean X_m = 113		Sum S = 860

number of samples: n = 10
number of degrees of freedom: n – 1 = 9
Chi squared: chi squared = 860 / 113 = 7.6
p in %: p in % = CHIVERT(7.6;9). × 100 = 56

Result: The calculated probability (56 %) is higher than 25 %. The mixture is excellent.

Example 2: Non - homogeneous mix

Sample number n	Corrected number of particles counted X_n	Difference $X_n - X_m$	Square of difference $(X_n - X_m)^2$
1	97	-51	2601
2	153	5	25
3	114	-34	1156
4	184	36	1296
5	58	-90	8100
6	155	7	49
7	115	-33	1089
8	181	33	1089
9	255	107	11449
10	164	16	256
	Mean X_m = 148		Sum S = 27110

number of samples: n = 10
number of degrees of freedom: n – 1 = 9
Chi squared: chi squared = 27110 / 148 = 183
p in %: p in % = CHIVERT(183;9) × 100 = 0

Result: The calculated probability (0 %) is below 1 %. The mixture is non-homogeneous.

Notes on evaluation of data:

First samples of batch 1:
The Microtracer level in the first samples of batch 1 can be lower than in the subsequent samples depending on the sampling place. This effect is called “negative carry-over”, because these first samples have a high chance to be mixed with product from the preceding batch where no Microtracer has been added.

Proceedings for strongly deviating single values:
If the particle count of one sample (X_i) deviates more than 20 % from the mean of all analysed samples (X_m), the analysis of this sample has to be repeated twice. Three different situations may occur:

a. all three analysed particle counts are lying close together (difference less than 20 %), then the first analysis of the three particle counts is chosen for the calculation of the uniformity.
b. two analysed particle counts are close together (difference less than 20 %), the third analysed particle count varies more than 20 %. The first analysis of the two particle counts which lie close together is chosen for the calculation of the uniformity.
c. all three analysed particle counts are differing more than 20 % from each other. This means the sample is inhomogeneous. The sample before and after this specific sample has to be analysed. Example: Sample 5 is inhomogeneous, sample 4 and sample 6 have to be analysed. If sample 4 and 6 are fitting to the evaluation of homogeneity, sample 5 is taken out.

2. Evaluation of carry-over

The following statistical data are relevant:

- Mean sample weight in batch 2 (=w_m)
- For each sample: mean number of Microtracer particles for w_m in batch 2
- The expected number of Microtracer particles for w_m in batch 1 (i.e. 100 % carry-over)
- For each sample: carry-over level in %
- Mean carry-over level in %

11. Reporting

The following will be reported:

- company specific information (section 4)
- details on sampling (section 7)
- if relevant information on preparation of samples (section 8)

For each group of samples:

- The measured and corrected Microtracer particle counts
- The relevant statistical data for homogeneity and carry-over, respectively

12. Literature

1. S. Artelt, A. Mertens: Microtracers versus traditional tracers
   Comparison of the suitability for measurement of mixing conformity and carry-over in feed production plants
   FeedMagazine/Kraftfutter 1-2/2018, pp 29-33
2. Anonymus: Microtracers – reliable checks on homogeneity and carry-over
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3. P. Platteschor: Garantiert sichere Produkte
   Verschleppung und Homogenität sind wichtige Aspekte für Tierfutterbetriebe
   De Molenaar 11/2014
4. C. Makkink: Microtracer: Verlässliche Kontrolle der Homogenität und Verschleppung
   De Molenaar 21/2006

5.8 Control procedure for the measurement of carry-over using micro-tracers by weighing

Note: This method is no longer used. Therefore this section will be removed at the time that all GMP+ documents will be restructured.

1. FIELD OF APPLICATION

See 5.7 Control procedure for the measurement of carry-over using microtracers

2. DEFINITIONS

Production plant: A production plant is an installation which is suitable for the preparation of compound feeds.

Microtracer mix: For the testing of a compound feed the microtrace mix contains 4 kg feed lime or wheat grits and 500 g microtracer. Therefore 500 g microtracer is mixed with 1 ton of compound feed, which corresponds to a mixing accuracy of 1: 2000.

3. PRINCIPLE

Use will be made for the measuring substance of the so-called RF microtracer (elementary iron particles). With an average number of particles of 1,000,000 per gram. For the microtracer particles it is a case of particle distribution; the average number of particles varies depending on the microtracer batch. In order to determine the number of particles in question in the test a microtracer mix is produced in which the average number of particles is determined exactly for the microtracer used.

The number of particles of microtracer in the samples which were taken is determined by separating the microtracer particles from the other feed particles using a rotary detector. The sample should be led twice over the rotary detector for this.

Once the sample has passed the magnet then the excess product is brushed from the filter with a brush, do this accurately and with a rotating magnet.
Remove the filter from the magnet and transfer and return the microtracer in a tared copper weighing boat.

NB 1: In order to correct for “factory iron” at least three blank samples will be measured. In the final calculation there should be a correction for the average of the blank measurements.

NB 2: When adding the microtracer mix there should be 500 gram/ ton added. The sample size should be 300-500 grams.

4. EQUIPMENT AND TOOLS

See 5.7 Control procedure for the measurement of carry-over using microtracers

5. COMPANY DETAILS REQUIRED

See 5.7 Control procedure for the measurement of carry-over using microtracers

6. ADDITION OF THE MICROTRACER MIX
See 5.7 Control procedure for the measurement of carry-over using microtracers

7. TAKING AND HANDLING SAMPLES
See 5.7 Control procedure for the measurement of carry-over using microtracers

8. DETERMINATION OF THE MICROTRACER PARTICLES
By way of double filtration using a rotation detector with a rotary magnet the microtracer particles from a sample are isolated because of their magnetic properties. Other magnetic particles are also filtered out at the same time.
The identification of the microtracer particles is done by weighing.

NB 1: In order to correct for “factory iron” at least three blank samples will be measured. In the final calculation there should be a correction for the average of the blank measurements.
NB 2: When adding the microtracer mix there should be 500 gram/ ton added. The sample size should be 300-500 grams.

9. PROCESSING OF THE RESULTS
See section 5.7 Control procedure for the measurement of carry-over using microtracers

10 REPORTING
See section 5.7 Control procedure for the measurement of carry-over using microtracers

11. ASSESSMENT OF THE RESULTS
See section 5.7 Control procedure for the measurement of carry-over using microtracers

12. REMARKS
See section 5.7 Control procedure for the measurement of carry-over using microtracers

13. SAFETY
See section 5.7 Control procedure for the measurement of carry-over using microtracers

14. PROCESSING OF COMPOUND FEED CONTAINING MICROTRACER
See section 5.7 Control procedure for the measurement of carry-over using microtracers

5.9 Control procedure for the measurement of carry-over in animal feed preparation using methyl violet

~~This text will be added later.~~

Note: This method is no longer used. Therefore this section will be removed at the time that all GMP+ documents will be restructured.

6 METHODS FOR MEASURING HOMOGENEITY OF DRY MIXTURES [2]

6.1 Introduction

The participant mixes feed materials, feed additives and veterinary medical products uniformly through the feed in accordance with the requirements in 6.7.1.2 in GMP+ B1 *Production, Trade and Services.* Measurement of the homogeneity of mixtures is in accordance with the protocols, which are laid down in this part of the appendix.

6.2 Frequency

A homogeneity test must be performed on each mixing installation. This test must done at least,

- At first use of the installation.
- At every significant change to the installation.
- Every 4 years.

6.3 Measurement of homogeneity

6.3.1 General

The measurement of homogeneity is statistically determined, by making use of direct or indirect methods.

6.3.2 Direct methods

Direct methods for measuring homogeneity are based on the **counting of particles**. So called microtracers are used as a measuring substance. Two different microtracers are suitable for the homogeneity analysis: Microtracer F and Microtracer FSS. Application of these methods lead to analysis results, which are analyzed as Poisson distributions. Homogeneity is expressed in terms of probability (p). The application of these methods must be in accordance with the description of the method in chapter 5 above.

[2] Dry compound feed or dry premixtures. Mixtures of liquid feed, emulsions, suspensions are out of scope.

Guidance

Example of the calculation of homogeneity with the direct Microtracer FSS method.
Dosage of Microtracer FSS is 10 g per ton of test mix

Homogeneity Batch	100 % filling dry, 50 Hz	
Planned batch size:	5392	
Overweight:	120	
Real batch size:	5512	
Addition of Microtracer Premix:	directly through an opening in the mixer on top of the mix	
Time for emptying of pre-bin to mixer:	15 s	
Dry Mixing Time:	90 s	
Addition of Liquids:	0 s	
Wet mixing time:	0 s	
Total mixing time:	105 s	
Sampling place:	after reddler before elevator	
Number of Samples:	22	
Sample Assayed, g:	20	
Tracer Color:	FSS-red lake	
Tracer Used per Metric Ton, g:	9,78	

Analytical results:

Sample No.	Sampling time [s]	Microtracer Particle Count	Sample Assayed [g]	Corrected Particle Count
1	0	74	19,46	76
2	10	102	21,50	95
3	20	92	21,29	86
4	30	97	21,59	90
5	40	97	21,27	91
6	50	92	20,54	90
7	60	103	21,01	98
8	70	92	20,69	89
9	80	100	21,06	95
10	90	87	21,01	83
11	100	77	20,94	74
12	110	85	21,11	81
13	120	95	20,01	95
14	130	83	19,97	83
15	140	83	21,97	76
16	150	88	20,30	87
17	160	85	20,68	82
18	170	82	20,67	79
19	180	83	20,02	83
20	190	73	19,97	73
22	210	82	20,09	82
24	230	82	20,05	82

Statistical Evaluation:

Number of Data	22
Degrees of Freedom	21
Mean, Particles	85
Standard Deviation, +/- Particles	7
c^2 Chi-square =	13,02
Probability, %	**91**
Tracer Recovery, % =	104

Mixing uniformity:
Mixing is excellent.

Table 1: Definitions for Mixing Uniformity

	direct tracer	indirect tracer
	Microtracer	example: Manganese
	Probability p	Coefficient of Variation cv
Mixing is excellent	> 25 %	< 5 %
Mixing is good	> 5 % - < 25 %	> 5 % - < 8 %
Mixing is acceptable	> 1 % - < 5 %	> 8 % - < 12 %
Mixing is incomplete	< 1 %	> 12 %

6.3.3 Indirect methods

Indirect methods for measuring homogeneity are based on the **determination of a concentration of a substance** (Microtracer RF Lake Blue, cobalt, or additive).
Indirect methods are:

- Method with tracer Microtracer RF Lake Blue
- Method with cobalt
- Method with tracer composed of an additive (Salinomycin)
- Method with a mix of manganese oxide and a protein-rich and a protein-poor mix

Application of these methods lead to analysis results, which are considered as being normal distributions. Homogeneity is given by the coefficient of variation (CV). The application of the above indirect methods must be in accordance with the descriptions in chapter 5.

6.4 Interpretation of homogeneity results

Depending on the method used, the results must be interpreted based on the limits in the next tables.

Determination of homogeneity by means of direct methods

Probability p	**Assessment**
p ≤ 1%	Insufficient
1% < p < 5%	Probably significant deviation. No unambiguous statement can be made. The test must be repeated.
P ≥ 5%	Good homogeneity

Determination of homogeneity by means of indirect methods

Coefficient of variation CV	**Assessment**
CV ≤ 8%	Good homogeneity
8% < CV < 12%	Acceptable homogeneity
CV ≥ 12%	Insufficient

In case the homogeneity of the mixture is assessed as insufficient, the GMP+ participant must:

- Report on the probable cause(s)
- Carry out corrective measures
- Perform a new homogeneity test in order to verify that the measures taken lead to a good homogeneity.

GMP+ International
Braillelaan 9
2289 CL Rijswijk
The Netherlands
t. +31 (0)70 – 307 41 20 (Office)
+31 (0)70 – 307 41 44 (Help Desk)
e. info@gmpplus.org