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Statistical Quality Control for Moisture Control

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1. ***Abstract*— Moisture control is one of the most important factors, which is to be monitor, review and control to maintain attract-ability of the feed as well as protecting from fungus as well from mould. Excess moisture is to be eliminated and required moisture to be maintained. Excess moisture leads to Fungus and as well as mould. Lower moisture may lead to loss of smell, creates dust, and affects its basic properties. By using Statistical quality control methods, cooler efficiency may be controlled and optimized moisture may be maintained in the feed.

***Keywords*— Attract, cooler, dust, feed, fungus, gelatinization, mash, moisture, mould, statistical quality control.**

I. INTRODUCTION

Feed manufacturing operations, moisture controls are monitored in various stages. During wet mixing process, Ground mash moisture is measured before going for wet mixing. In wet mixing process, clean water will be added for better mixing as well as for better gelatinization process. Quality steam is added to increase temperature as well as for gelatinization. Moisture will be measured again for control in other process. Since water added, steam added and moisture carried from various raw materials but final moisture should be under control. Statistical Quality Control (SQC) will be help us in various stages to monitor and to find the way, where we are , so that we may control process parameters to attain desired moisture levels.

II. GUIDE LINES

The feed manufacturing process starts from receipt of raw materials, micro minerals, macro minerals, vitamins and various oils. After clearing from quality checks, the following production process will be taken place. Refer flow chart fig no.

1. Raw material dumping: Dumping of various raw materials, which will be loaded to pre defined bins.
2. Pre-grinding: Rough grinding will be carried out for pre defined raw materials, and then will be loaded to specified raw material bins.
3. Auto batching : Every raw material will be measured and taken to the scale as per pre-programmed formulation
4. Dry mixing: Mixing with double shaft paddle mixture for predefined time.
5. Grinding: Mixed batches are fed into the vertical pulverising system for fine grinding. The output mash will be verified for its fineness. Moisture percentage will be measured and recorded along with batch number.
6. Wet mixing along with minerals, water and oils: Finest mash will be fed into wet mixer along with water, minerals and oils. The quantity of water is based on moisture at given mash and relative humidity of atmospheric air.
7. Pre-conditioning (Gelatinization) with added steam: The mash is feed into the double shaft pre-conditioner along with steam.
8. Pellet: Pellets will be drawn from rotating die, which is mounted on mill. Appropriate size will be cut through pre-fixed blades. Pellets will be dropped to post conditioning.

9. Post conditioning: Curing takes place in post conditioning at specific temperature with pre defined time based on size of the pellet. A closed jacket post conditioners acts as treatment of pellets to improve water stability, hardening pellets and colour will be maintained. The pellet spending inside the post conditioner is based on size of the pellet, length of the pellet as well as the formulation of ingredients used in pellet making. The volume of the pellet plays one the major roll since discharging of pellets from post conditioner is linked with lower and upper limits set with volume based.
10. Cooling: Cooling the pellets and reducing moistures are taking into the consideration. By using statistical quality control methods, we may find actual reduction of moisture from feed pellets and controls with adjusting butterfly valve. Whereas the problem is atmospheric conditions effect the moisture and butterfly valve is to be adjusted very frequently.
11. Screening: Differentiate the higher size pellets, right size pellets, and undersize pellets. Based on sizes, right size pellets go through the de-dusting line. Over size pellets or lumps will be taken into a separate bin. Under size pellets may consider for crumbling or work in progress, so that the same may be used for other purpose.
12. De-dusting: Dust and powder will be drawn to a separate bin through the dust collector and will be used for specific purpose.
13. Weighing: Pellets will be drawn from bin to the weighing system, where the pellet will be measured for its required weight and forwarded to the gross weight system. During gross weight , bag weights, creep roll weight, thread weight will be considered based on required pre-defined weight and processed if it is in within tolerable range, otherwise alarm will be activated and process will be stopped for correction.
14. Packing: The forwarded bags with pellet feed will be packed and sent for dispatch.

III. TABLES.

Pellet Size : Diameter 1.2 mm X Length 3.5 mm				
Cooler In Put				
Sample No	**Batch 641**	**Batch 642**	**Batch 643**	**Batch 644**
Sample 1	12.50	12.25	12.00	12.10
Sample 2	12.10	12.25	12.25	12.25
Sample 3	12.30	12.50	12.50	12.15
Sample 4	12.10	12.50	12.25	12.25
Sample 5	12.10	12.40	12.25	12.15
Sample 6	12.00	12.50	12.00	12.25
Sample 7	12.10	12.30	12.25	12.00
Sample 8	12.25	12.45	12.25	12.50
Sample 9	12.25	12.25	12.50	12.25
Sample 10	12.50	12.20	12.25	12.20

Table I: Cooler input

Pellet Size : Diameter 1.2 mm X Length 3.5 mm				
Cooler Out Put				
Sample No	**Batch 641**	**Batch 642**	**Batch 643**	**Batch 644**
Sample 1	11.40	11.20	11.00	11.00
Sample 2	11.10	11.20	11.15	11.10
Sample 3	11.30	11.40	11.40	11.15
Sample 4	11.20	11.40	11.25	11.00
Sample 5	11.15	11.50	11.25	11.25
Sample 6	11.10	11.50	11.10	11.10
Sample 7	11.10	11.30	11.20	11.10
Sample 8	11.20	11.40	11.20	11.50
Sample 9	11.20	11.20	11.40	11.20
Sample 10	11.45	11.25	11.20	11.20

Table II: Cooler output

Pellet Size : Diameter 1.6 mm X Length 4.0 mm				
Cooler In Put				
Sample No	**Batch 701**	**Batch 702**	**Batch 703**	**Batch 704**
Sample 1	12.10	12.00	12.50	12.40
Sample 2	12.50	12.10	12.45	12.35
Sample 3	12.45	12.50	12.50	12.35
Sample 4	12.50	12.40	12.50	12.40
Sample 5	12.35	12.35	12.35	12.45
Sample 6	12.25	12.45	12.50	12.35
Sample 7	12.50	12.50	12.45	12.50
Sample 8	12.35	12.45	12.35	12.50
Sample 9	12.40	12.35	12.40	12.50
Sample 10	12.50	12.50	12.45	12.35

Table III: Cooler input

Pellet Size : Diameter 1.6 mm X Length 4.0 mm				
Cooler Out Put				
Sample No	**Batch 701**	**Batch 702**	**Batch 703**	**Batch 704**
Sample 1	11.20	11.00	11.40	11.50
Sample 2	11.60	11.20	11.45	11.40
Sample 3	11.30	11.40	11.50	11.40
Sample 4	11.50	11.40	11.40	11.35
Sample 5	11.40	11.30	11.40	11.35
Sample 6	11.30	11.30	11.50	11.40
Sample 7	11.60	11.45	11.50	11.50
Sample 8	11.40	11.35	11.30	11.50
Sample 9	11.50	11.35	1.30	11.45
Sample 10	11.40	11.60	11.40	11.40

Table IV: Cooler output

Pellet Size : Diameter 1.8 mm X Length 5.0 mm				
Cooler In Put				
Sample No	**Batch 750**	**Batch 751**	**Batch 752**	**Batch 753**
Sample 1	12.40	12.40	12.30	12.50
Sample 2	12.50	12.60	12.50	12.30
Sample 3	12.50	12.50	12.30	12.50
Sample 4	12.40	12.30	12.40	12.50
Sample 5	12.35	12.50	12.30	12.40
Sample 6	12.40	12.60	12.50	12.30
Sample 7	12.30	12.40	12.40	12.40
Sample 8	12.50	12.60	12.30	12.30
Sample 9	12.30	12.30	12.50	12.50
Sample 10	12.40	12.50	12.40	12.30

Table V: Cooler input

Pellet Size : Diameter 1.8 mm X Length 5.0 mm				
Cooler Out Put				
Sample No	**Batch 750**	**Batch 751**	**Batch 752**	**Batch 753**
Sample 1	11.35	11.30	11.45	11.50
Sample 2	11.55	11.40	11.40	11.40
Sample 3	11.40	11.40	11.40	11.40
Sample 4	11.40	11.50	11.40	11.35
Sample 5	11.40	11.30	11.35	11.35
Sample 6	11.50	11.40	11.30	11.40
Sample 7	11.50	11.40	11.50	11.50
Sample 8	11.50	11.30	11.40	11.50
Sample 9	11.40	11.30	11.40	11.45
Sample 10	11.50	11.40	11.30	11.40

Table VI: Cooler output

Pellet Size : Diameter 1.2 mm X Length 3.5 mm				
Cooler In Put				
Sample No	**Batch 775**	**Batch 776**	**Batch 777**	**Batch 778**
Sample 1	12.70	12.35	12.15	12.15
Sample 2	12.50	12.30	12.30	12.15
Sample 3	12.30	12.40	12.20	12.10
Sample 4	12.40	12.55	12.15	12.30
Sample 5	12.25	12.30	12.15	12.40
Sample 6	12.20	12.45	12.10	12.35
Sample 7	12.30	12.35	12.20	12.20
Sample 8	12.35	12.35	12.20	12.40
Sample 9	12.35	12.35	12.40	12.35
Sample 10	12.40	12.10	12.55	12.40

Table VII: Cooler input

Pellet Size : Diameter 1.2 mm X Length 3.5 mm				
Cooler Out Put				
Sample No	**Batch 775**	**Batch 776**	**Batch 777**	**Batch 778**
Sample 1	11.70	11.30	11.30	11.25
Sample 2	11.40	11.30	11.30	11.25
Sample 3	11.30	11.40	11.25	11.25
Sample 4	11.35	11.45	11.25	11.30
Sample 5	11.30	11.35	11.25	11.35
Sample 6	11.30	11.40	11.25	11.35
Sample 7	11.30	11.40	11.25	11.30
Sample 8	11.35	11.35	11.30	11.30
Sample 9	11.35	11.30	11.30	11.35
Sample 10	11.40	11.25	11.50	11.40

Table VIII: Cooler output

Pellet Size : Diameter 1.6 mm X Length 4.0 mm				
Cooler In Put				
Sample No	**Batch 780**	**Batch 781**	**Batch 782**	**Batch 783**
Sample 1	12.55	12.50	12.45	12.75
Sample 2	12.45	12.75	12.65	12.55
Sample 3	12.65	12.55	12.55	12.65
Sample 4	12.75	12.25	12.45	12.65
Sample 5	12.65	12.35	12.55	12.55
Sample 6	12.60	12.45	12.65	12.55
Sample 7	12.55	12.65	12.60	12.60
Sample 8	12.65	12.55	12.70	12.65
Sample 9	12.30	12.30	12.55	12.50
Sample 10	12.50	12.40	12.70	12.65

Table IX: Cooler input

Pellet Size : Diameter 1.6 mm X Length 4.0 mm				
Cooler Out Put				
Sample No	**Batch 780**	**Batch 781**	**Batch 782**	**Batch 783**
Sample 1	11.60	11.50	11.50	11.65
Sample 2	11.40	11.65	11.60	11.55
Sample 3	11.60	11.50	11.50	11.60
Sample 4	11.60	11.35	11.45	11.65
Sample 5	11.55	11.35	11.50	11.50
Sample 6	11.50	11.40	11.55	11.55
Sample 7	11.50	11.60	11.55	11.60
Sample 8	11.60	11.60	11.65	11.65
Sample 9	11.35	11.45	11.50	11.60
Sample 10	11.45	11.45	11.65	11.60

Table X: Cooler output

Pellet Size : Diameter 1.8 mm X Length 5.0 mm				
Cooler In Put				
Sample No	**Batch 790**	**Batch 791**	**Batch 792**	**Batch 793**
Sample 1	12.95	12.85	12.95	12.65
Sample 2	12.75	12.90	12.90	12.60
Sample 3	12.70	12.80	12.80	12.55
Sample 4	12.70	12.70	12.90	12.65
Sample 5	12.60	12.70	12.80	12.65
Sample 6	12.55	12.60	12.75	12.55
Sample 7	12.60	12.50	12.85	12.70
Sample 8	12.50	12.75	12.70	12.80
Sample 9	12.50	12.70	12.80	12.80
Sample 10	12.70	12.90	12.90	12.70

Table XI: Cooler input

Pellet Size : Diameter 1.8 mm X Length 5.0 mm				
Cooler Out Put				
Sample No	**Batch 790**	**Batch 791**	**Batch 792**	**Batch 793**
Sample 1	11.85	11.80	11.75	11.60
Sample 2	11.80	11.85	11.75	11.60
Sample 3	11.75	11.75	11.80	11.50
Sample 4	11.75	11.70	11.85	11.55
Sample 5	11.65	11.70	11.85	11.55
Sample 6	11.60	11.70	11.80	11.60
Sample 7	11.60	11.60	11.80	11.60
Sample 8	11.50	11.70	11.85	11.75
Sample 9	11.55	11.70	11.75	11.75
Sample 10	11.65	11.85	11.80	11.70

Table XII: Cooler output

IV. Graphs

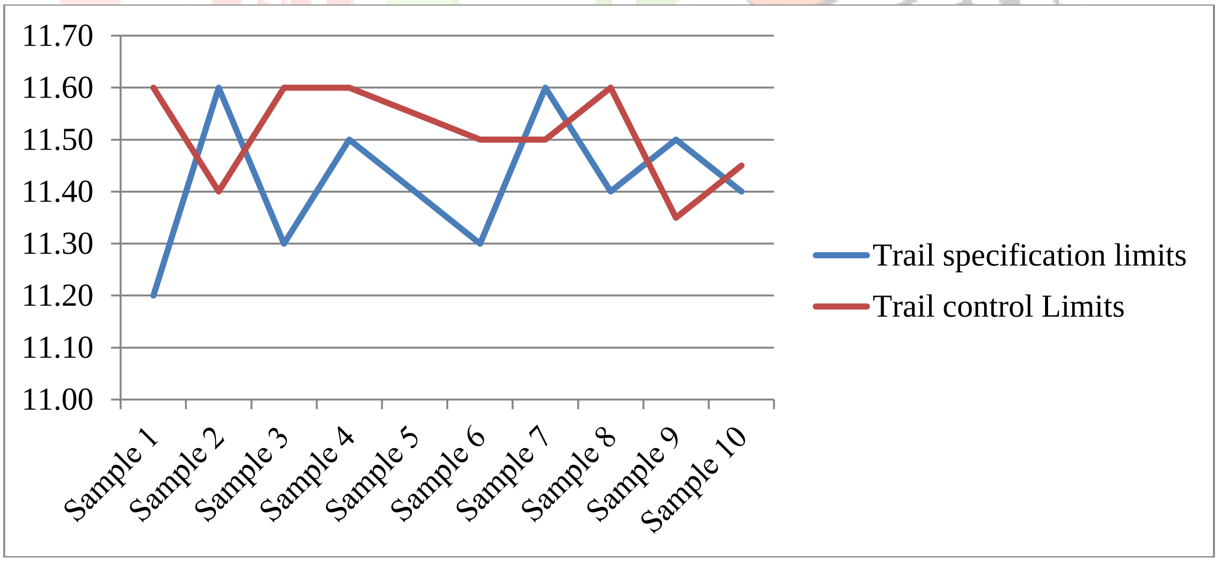

Fig 1.0 Sample comparison between specification limit and control limit.

V. DATA ANALYSIS

During samples drawn from existing system, the deviation is not co-related with inputs even output is within the specification limit. This may be due to atmospheric conditions since relative humidity is variable time to time, whereas butterfly valve for air flow is static. The enclosed tables I,III,V are cooler input moistures for sizes 1.2 mm, 1.6 mm and 1.8 mm diameter pellets, the tables II,IV,VI are output moistures respectively for the same size pellets.

The basic specification limit for cooler output is as follows.
Lower specification limit: 11.00 %
Higher specification limit: 12.00 %

Control limits are derived as follows.
Lower control limit: 11.25 %
Higher control limit: 11.75%

VI. CONCLUSION

Various trails conducted with base parameters and data is reviewed. Found that the values are within specification range and acceptable where as some the values are nearby upper as well as lower specification limits. Which may cross limits at any instance may lead to rejecting of complete batch which is huge economic loss. By introducing dynamic moisture control system which allows to controls air flow based on relative humidity as well cooler input moistures. After introducing , there are similar trails conducted which are shown in tables VII,IX,XI are cooler input moistures and tables VIII,X,XII are cooler output moistures which are found within control limits. The graph in fig 1 shows out line comparison for a sample test. This is further may need fine tuning of control system but overall it seems to be good. Statistical quality control systems really help us to tuning of moisture control in line with requirements.

VII. REFERENCES

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