Energy Saving and Dust Management in Urea & Bagging Plant

Prem Baboo
Sr. Manager (Prod)
National fertilizers Ltd. India
Sr. advisor for www.ureaknowhow.com

Abstract - **This paper intended how to recover useful urea dust to control air pollution and that of saving energy. Lot of urea dust is emitted during product handling like falling from one conveyor to another, screening, de-lumping, bagging, etc. To recover the dust, wet de-dusting systems are installed. In the dust recovery system urea particles suspended in the air stream are dissolved into water. Dust controls an example of sustainability. National fertilizers Ltd always look at ways of saving the environment, by optimizing their basic processes, raw material utilization, saving water etc. As a socially responsible company, one such illustrative example is the dust control project in urea conveyors system. Fugitive dust is an on-going issue faced by most conveyor operators working with fine or powdered material. With raised awareness spurred by tighter regulatory standards, effective dust management has become an increasingly important challenge, motivating operators to employ efficient, cost-effective methods of particle management. Urea dust produces in handling of urea by conveying system with hopper assembly & bunkering. Urea dust at the conveyors hopper is mainly due to impact and attrition. Fertilizer dust emission is an increasingly serious problem creating a growing concern about atmospheric pollution and its possible ecological and toxicological effects. Contact with urea dust is a recognized health hazard. The handling and storage of urea requires special attention to several product related properties and external factors. Dust particles produced depends upon process condition, e.g. temperature, weather condition and equipment used for conveying system. External factors including climatic humidity and how urea is stored and for how long also play a big part. Dust is an ongoing issue faced by most conveyor operators working with fine or powdered material. In addition to providing a safe clean workplace, choosing the equipment best suited to managing urea's hygroscopic qualities will save time and money. Together, these factors can have a significant impact on the cost of operation. Because of the varying types and diversity of dust control methods, powder and fine material handlers should consider evaluating causes, problem areas, dust-generating processes and potential cargo management techniques to arrive at the optimum approach for their operation.**

Key words- Solid Waste, Dust Pollution, Conveyers, Cyclone Separator. Prilling Tower. Explosion.

INTRODUCTION:

National Fertilizers Ltd, (NFL) operates a fertilizer complex at Vijaipur, Distt. Guna (Madhya Pradesh) consisting of two units Vijaipur-I and Vijaipur-II, plants were commissioned in December 1987 and March 1997 respectively. Ammonia Plants are based on M/s. HTAS's Steam Reforming of Natural Gas and Urea plants are based on M/S. Saipem's Ammonia Stripping technology. NFL, a Schedule 'A' & a Mini Ratna (Category-I) Company. The Vijaipur unit, which is an ISO 9001:2000 & 14001 certified, comprises of two streams. The Vijaipur have two ammonia plant M/S. Haldor Topsoe Technology, Denmark capacity 1750 & 1864 TPD for Line-I & line-II respectively and four urea plant of M/S. Saipem ammonia stripping process, Italy. The Line-I plant installed in 1988 and that of line –II in 1997.The capacity of Urea-I urea –II is 3030 & 3231 TPD respectively. The raw material used includes natural gas, water and power. Bagging plant has two urea silo system with capacity 50,000MT each. In urea Conveying system dust recovery system installed with cyclone separator and this urea solution recovered in main urea plant. The bagging plant is located at the eastern part of the factory complex and designed to handle 8800MT of urea with both the silo scrapper delivering the material on 12 hourly bases to their full capacity 150 T/hr. out of 8800 MT 6600 MT is coming from both the urea plants line-I & line-II. NFL takes utmost care in all its processes, to safe guard the environment with focus on continuous improvement through research, the processes are often revisited and improved to cater to the changing needs and stringent global requirements.

Purpose of Urea Dust Recovery System

1. Dust pollution control.
2. Energy saving by recovery of Urea.
3. Urea quality Control
4. Safe cleaned workplace.
5. To avoid Urea dust explosion in ignition range*

*(Ignition of urea dust although mixtures of dust and air within the flammable range are capable of explosion, they will not explode unless they are ignited in some way. Once a source of ignition is presented to the flammable mixture, flame will propagate throughout.) Urea Undergoes thermal decomposition at elevated temperatures to produce solid cyanuric acid and releases toxic and combustible gases (ammonia, carbon dioxide, and oxides of nitrogen). May explode when mixed with certain strong reducing substances (hypochlorite's) forms nitrogen dichloride which explodes spontaneously in air.

Urea Explosive conditions

Ignition Temp – 520^0C
Min Ignition Energy -100 MJ
Lower Explosive Limit -125 g/m^3
P (max)-9.7 bar
Kst-119 Bar.m/sec

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Description of bagging conveying system

In bagging plant two numbers of silo each having capacity 50,000MT. The first group of collecting urea prills from both the prilling on ET-1 or ET-21 belts conveyers and then transport it through various belt conveyors up to silo -1 and silo -2.The second group contains the equipment's receiving fresh urea prills transported from prilling towers to silo transfer control room (STCR) and reclaimed urea through scrappers is transported to bagging plant building by belt conveyors. In the third group the urea is received at bagging plant building and is distributed to the various sections (bunkers) according to the process requirements by conveyors. In main bagging plant building the material flow have been divided into three major streams

1. 'A" Side- there are 6 Numbers old model bag filling stations in these streams and used for rail loading.
2. 'B" Side- there are 7 numbers bag filling station in this side (6 numbers are old model and one new model and used for rail load.
3. 'C" Side- there are 5 bag filling stations these are either truck or rail loading.

Urea Dust recovery& Controlling system in belts Conveyor hoppers & Bunkering

Because of the varying types and diversity of dust control methods, powder and fine material handlers should consider evaluating causes, problem areas, dust-generating processes and potential cargo management techniques to arrive at the optimum approach for their operation. Categorized as either respirable or inhalable according to particle size, dry, solid dust particles range from about 1 to 100 microns (μm) in diameter. According to the U.S. Environmental Protection Agency, inhalable dust particles (larger than 10 μm) are typically caught by the nose, throat or upper respiratory tract. In contrast, respirable dust particles (under 10 μm) have the potential to penetrate beyond the body's natural cleaning mechanisms, (cilia and mucous membranes) traveling deep into the lungs where they are likely to be retained. Virtually any activity that disturbs bulk material is likely to generate dust; however, crushed, fine and powdered substances pose a unique problem. Bulk conveying operations and trucks or railcars dumping loads of raw material often struggle to manage this fugitive material, as well as any activity involving heavy loading equipment. Because they move large amounts of material at high speeds, conveyors can be a complex source of fugitive material. Transfer points composed of drop chutes, impact points and conveyor enclosures are notorious dust sources unless properly designed, installed and sealed. In fact, with today's larger, faster conveyor systems, virtually the entire belt path can be a contributor to the release of dust.

In National fertilizers Limited Three numbers dust recover system in each hopper and separate dust recovery system in bunkering.

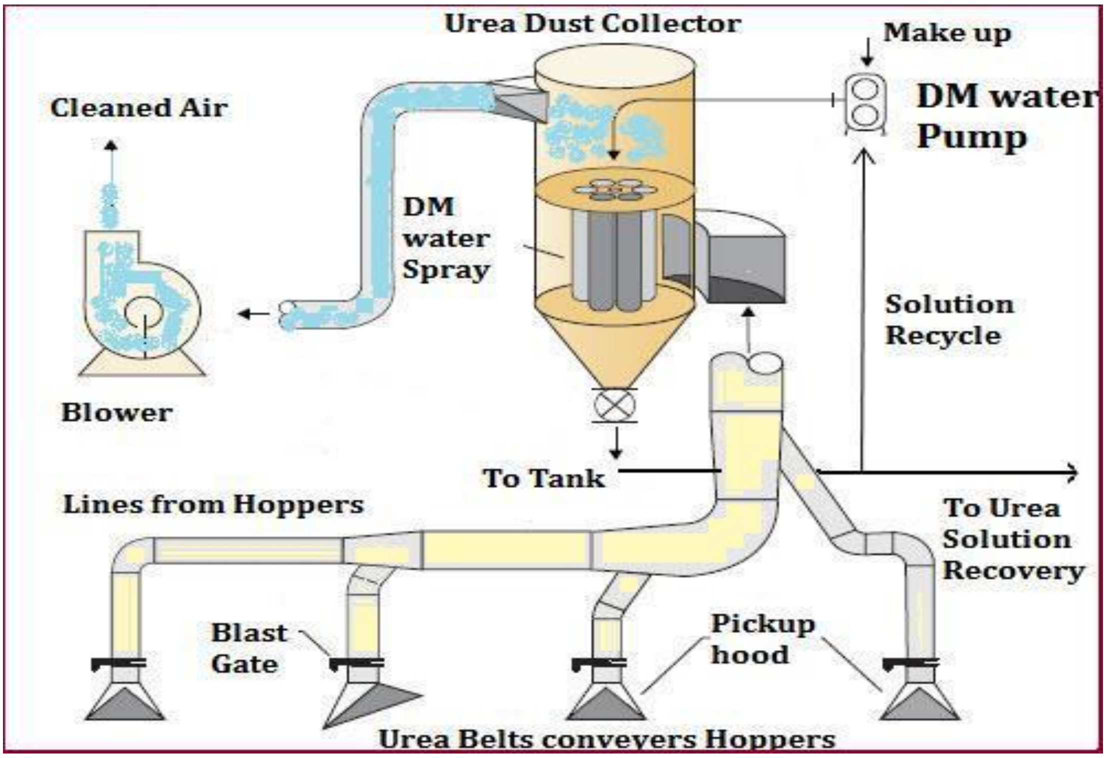

Fig-1

In bunkering system high capacity blowers are installed to suck urea dust. The system containing High capacity blower, Dust absorber D.M. water tank solution transfers pumps, Level indicators and urea density meters. Urea is quite soluble in water (1 g in 1 mL) so there is no question as to the spontaneity of the process at room temperature. This tells us something else about the dissolving of urea in water: the entropy change in the universe is positive. In the case of urea and water the situation looks very promising. Substances are polar, both can hydrogen bond, and while urea is somewhat larger than water it is not grossly out of scale. Urea is difficult to dissolve when too little water is

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present, and it will be too diluted if too much water is used. The lean solution circulates to improve urea concentration and when urea concentration reached about 25-30 % then solution transfer to Urea line-1 and line-2 plants. This solution taken in urea dissolving tank and mixed with urea solution tank to recovers in vacuum section.

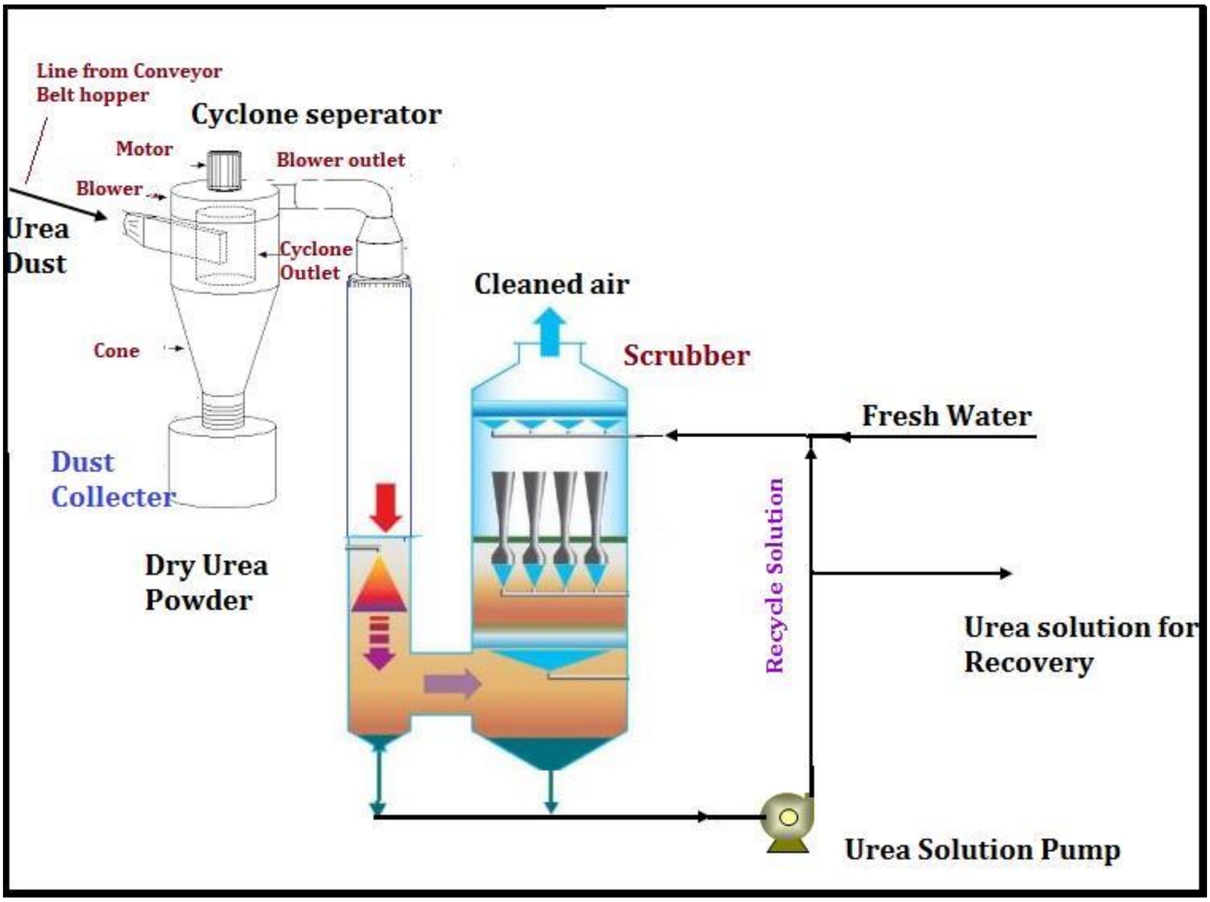

Fig-2

Benefits of the Project

About 5.5 Ton per day urea dust recovered by conveyer's dust recovery system i.e. the energy saving as well as environmental benefits. Dust collection system improves air-quality and reduces health risk. Bagging operations are conducted inside warehouses and are usually vented to keep dust out of the workroom area, as mandated by Occupational Safety and Health Administration (OSHA) regulations. Most of the hoppers/bunkering are controlled with dust absorption system. Urea dust presently control particulate matter emissions from prill towers, coolers, hoppers, bulk flow cooler and bagging operations. Scrubber systems are preferred over dry collection systems primarily for the easy recycling of dissolved urea collected in the device. Scrubber liquors are recycled to the solution concentration process to eliminate waste disposal problems and to recover the urea collected.

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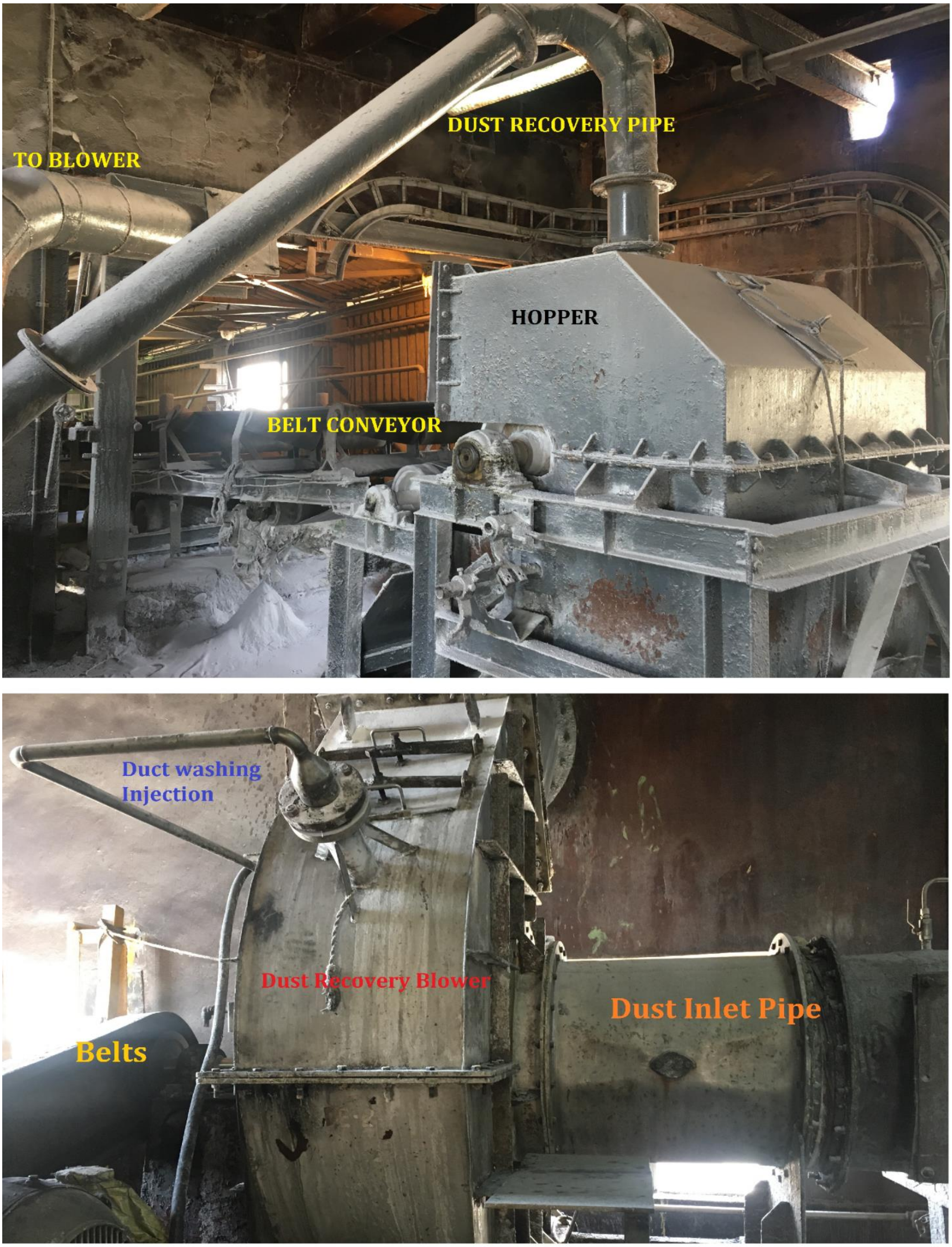

Fig-3

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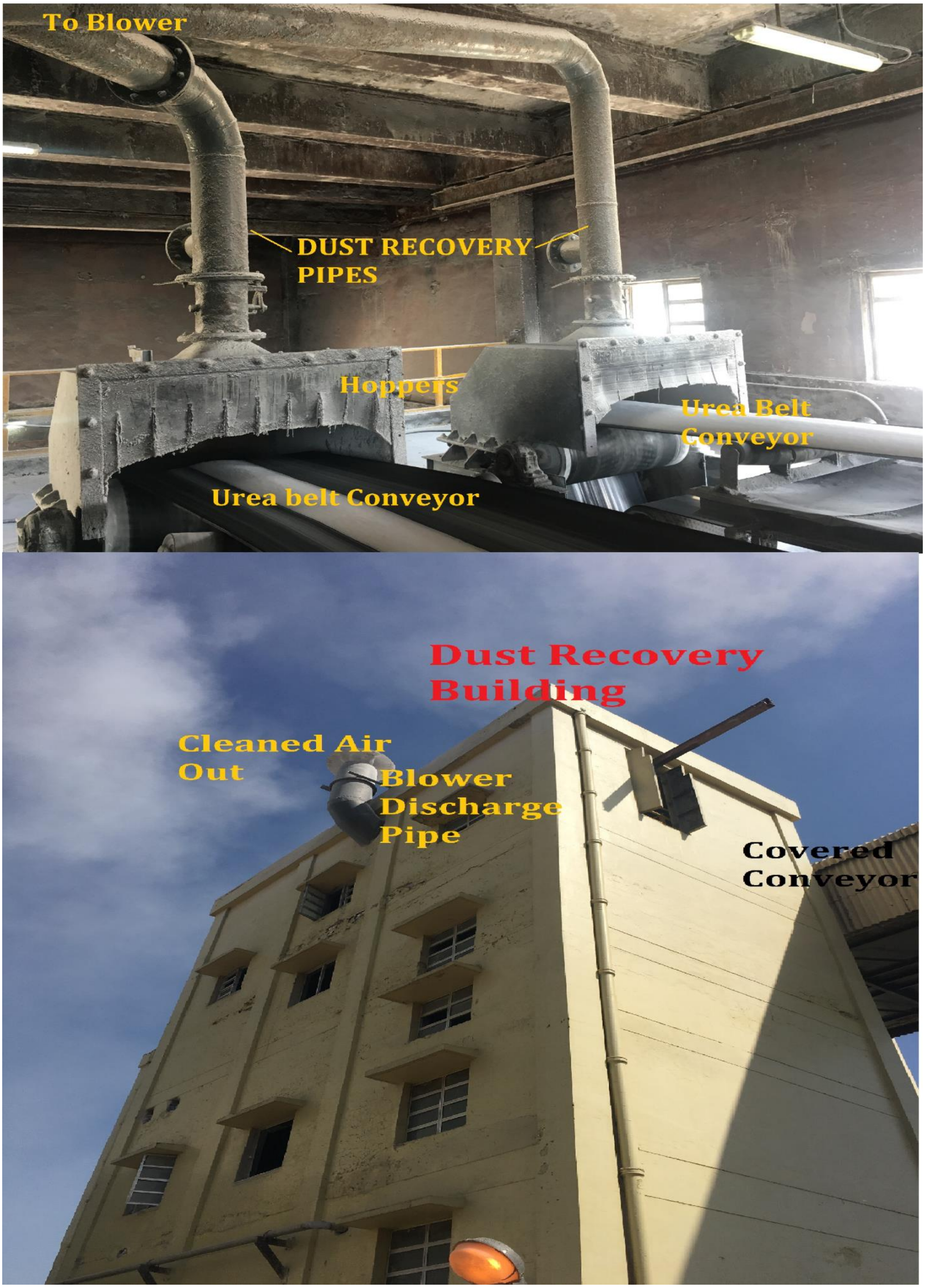

Fig-4

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Dust Recovery system in Bulk Flow Cooler (Solex)

The dedicated dust recovery system installed in Bulk flow cooler. Bulk flow cooler takes in line in peak summer when prills temperature reach above 70^{0}C.The Solex Bulk flow cooler cool down temperature of prills to 60^{0}C. Since the air used for cooling (see Fig-5) the bulk solids never comes into direct contact with the product, the risks of bacterial or odour contamination are virtually eliminated, as are emissions, dust and fines.

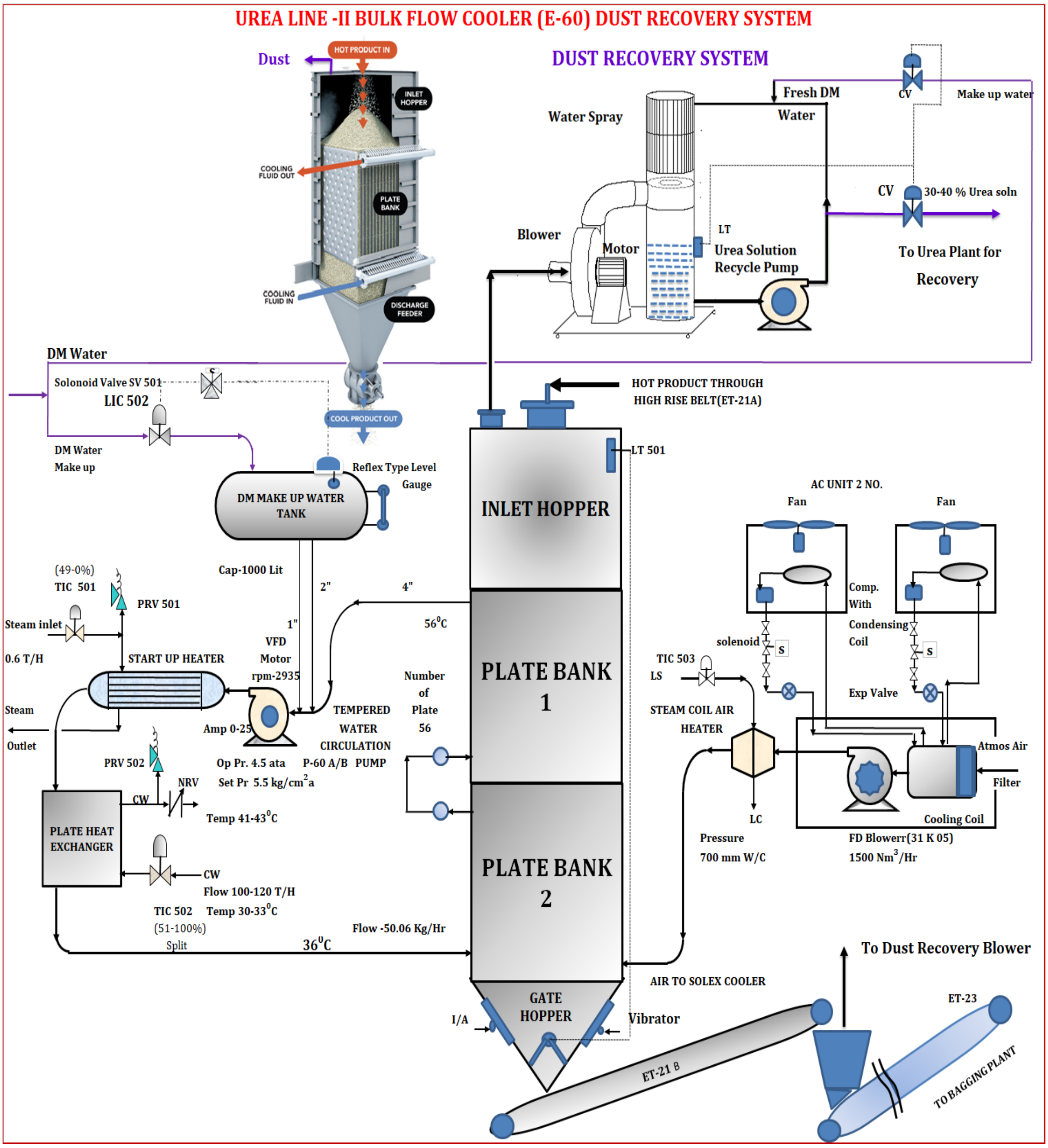

Fig.-5

Urea Dust control in Prilling Tower Exhaust

The plant is having a natural draught Prilling Tower with continuous emission of Urea Dust Particles and Ammonia to the atmosphere which was the latest technology at that time. The height of the Prilling tower is about 98 meter for line-1 and 104 meter for urea line-2, diameter of prilling tower are 28 & 26 for line-1 & line-2 respectively and the exhaust was let to the atmosphere without any dust-recovery system. The urea dust and ammonia gas emission from prilling tower as per international standards. As a strategic proactive approach some of the plants have reduced the urea dust, ammonia emission and waste water discharge from Urea plant by implementing a prill tower dust recovery systems but we are maintained dust emission with louvers of prilling tower and process control parameters.

Environment Standard for Prilling Tower Dust
(Source EPA Notification S.O.63 (4) dt.18th Jan 1988)

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Year of commissioning	Pollutant	Emission Limit
Prilling Tower commissioned **prior** to 1.1.1982	Particulate matter	150 mg/Nm3 or 2.0 kg/tonne of urea
Prilling Tower commissioned **after** 1.1.1982	Particulate matter	50 mg/Nm3 or 0.5 kg/tonne of Urea

Table -1

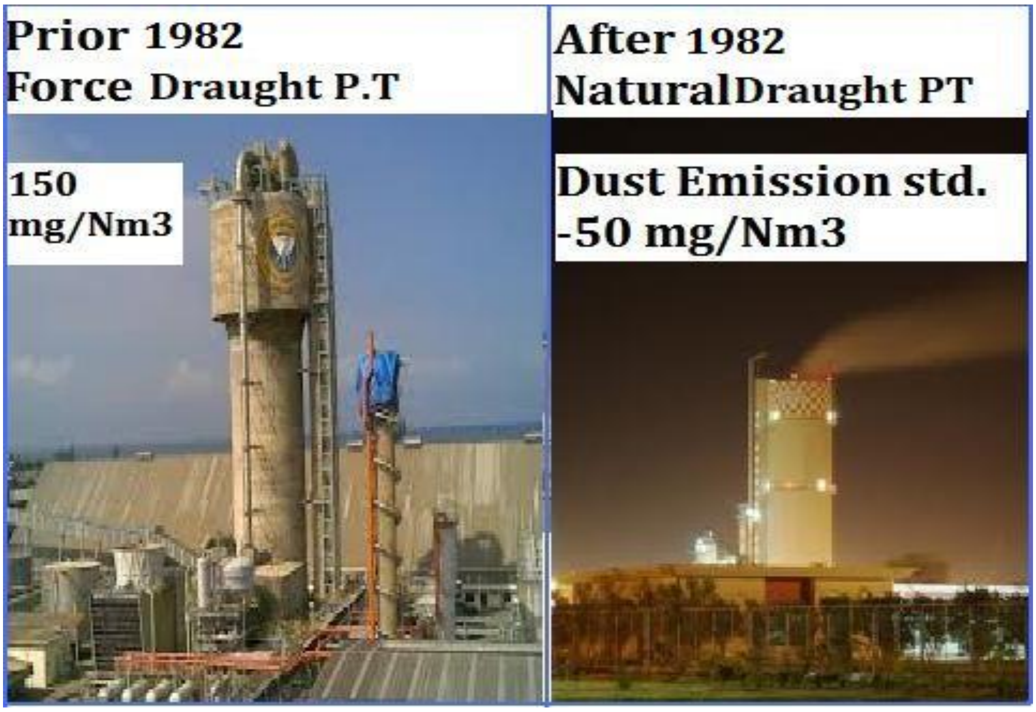

Fig-6

Dust Generation Mechanism

1. Internal causes
2. Controlling causes.

Internal causes

1. Such as decomposition of urea of prilling impact and attrition.
2. High temperature of urea melt i.e.,>136^{0}C and low partial pressure cause urea to decompose cynic acid.

$NH_2CONH_2 = NH_3 + HCNO$

It is observe that under normal condition the dust contain iso-cynic acid (HNCO).Urea dust can be controlled by simple following technique

1. Prilling bucket temperature not more than 136^{0}C
2. Top & bottom louvers should be cleaned.

Dust of the leaving the bucket due to cooling the small urea droplet is again formed by sublimation which cause dust formation. Another source may be the breakage of prill due to impact after leaving the bucket if the free ammonia is present more due to process upset the dust generation is more.

Controlling Causes

1. Excess temperature of bucket i.e.,>136^{0}C
2. Partially choked holes of the bucket.
3. Irregular holes of the bucket.
4. Overloading of plant.
5. Choking of louvers.
6. Leakage of steam/condensate to melt line.
7. Prilling bucket overflowing due to holes chocked or less rpm of the bucket.
8. Inadequate vacuum, leading to high moisture contents.
9. Excessive pressure exerted by scrapper.
10. Dissolving of dirty urea.
11. Temperature of the prilling bucket should be maintain 134^{0}C
12. Vacuum of the both stage should be maintain as designed.
13. V-5 (urea tank) solution should be consumed immediately otherwise biuret content will be high.
14. Louvers opening should be maintain according as ambient condition.
15. RPM of the bucket should be maintaining according to size, i.e., on the wall speed & overflow speed.
16. Visual checking of product quality on continuous basis.
17. Thorough cleaning of Prilling bucket before installation.
18. Maintaining proper vacuum in both the streams.
19. Adjusting Prilling Bucket speed based on visual.
20. Checking and lab reports.
21. Regular cleaning of scrapper floor and top louvers.
22. Flushing of vacuum condensers twice a shift for maintaining proper vacuum.
23. Flushing of vacuum separators on alternate days.
24. Regular cleaning of Urea recovery pump strainers and ensuring no bypassing in them.

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Dust and Ammonia emission in line-1 & line-2 as following-

Sr.	Date	Urea Line-1 Plant			Urea Line-2 Plant		
		Urea Dust	Ammonia	Prills Temp.	Urea dust	Ammonia	Prills Temp.
No.		mg/Nm^3	mg/Nm^3		mg/Nm^3	mg/Nm^3	
1	06/05/2016	45	75	68	46	78	64
2	08/05/2016	44	74	67	45	77	63
3	07/12/2017	35	54	42	33	48	41
4	19/12/2017	33	53	41	31	47	40
5	28/12/2017	31	41	40	42	48	39
6	01/01/2018	33	42	40	38	46	40
7	15/01/2018	32	43	39	37	44	37
8	01/02/2018	31	42	41	36	43	41

Table-2

The dust and ammonia emission in winter is less than summer as shown in the above tables because the dust generation is the function of temperature.

CONCLUSION

Improving dust control requires an understanding of how elements of the dust collection system Work together. Sources of dust must be controlled at the point of origin by better sealing and containment. Hoods and ducting must be properly designed and located throughout the system. The hopper may be improved as streamline flow rather than scattered flow so that dust emission can be minimized. Vacuum in pipe line must be properly sealed.Every conveying system has its unique characteristics. Users should examine the features, construction and trouble points of individual systems, without making general assumptions that could lead to unsatisfactory results. Due to the significant number of complicated variables, which are constantly altered by changes in environment and materials, powder handlers implement a variety of process designs and plant layouts. Dust conditions and the methods of control are affected by production techniques and technologies, system options and equipment choices, as well as differences in conveyor design and construction.

Dust management should be an integral part of the material handling system, optimized to

Prevent fugitive dust by:

1. Applying containment in the right places.
2. Applying controlled amounts of moisture to improve agglomeration.
3. Utilizing air cleaners when moisture is not an option or excess air is present.
4. Control moisture in product by changing in vacuum evaporation system.
5. Control biuret ($NH_2CONHCONH_2$) and triuret($(NH2CO)_3N$) in the system to optimized polymerization

Major changes in moisture or alterations in the process or equipment (increasing belt speed or Cargo volume, for example) can have dramatic consequences on dust management. Even minor changes in environment such as a change in the atmospheric humidity can impact performance and flow. However, if an existing material handling system successfully manages dust and spillage upon installation, it should continue to work as long as the conditions stay relatively consistent and the equipment does not suffer wear or abuse that alters its performance.

REFERENCES-

*Ignition data taken from
http://www.dustexplosion.info/dust%20explosions%20-%20the%20basics.htm

Legends

EPA-Environment Protection Agency, S.O.-Statutory Order ,TPD-ton per day, MT-metric ton, μm-micro meter, MJ-Mega joule, D.M.-De-Mineralized.