Installation of Non-condensable Gases Handling System under Environmental Management

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Abstract

Industry's responsibility towards society has made environmental management an important and essential ingredient in the present scenario. To demonstrate the commitment it became necessary to explore the state- of art technologies even at considerable investment and higher operating costs. This paper deals with the description of the Non Condensable Gases Handling System installed for the first time in India at APPM and experiences in absorption of this modern technology as a case study.

INTRODUCTION

The Andhra Pradesh Paper Mills Limited situated at Rajahmundry has installed capacity of 98500 TPA of writing, printing and industrial varieties of paper. Raw material mix is local mixed hard woods consisting of Casurina, Subabul and other hard woods upto 85% and bamboo 15%. Kraft pulping process is being done with moderate sulphidity (20%) of white liquor. This sulphidity level is lower compared to about 30% used in other countries and hence results information and release of comparatively lower NCG during pulping and recovery.

The mill used to take care of strong NCG from evaporation plant and digester degassing by scrubbing with white liquor. The efficiency of the system is about 90% and to avoid complete release of strong NCG thereby to contain odour, APPM has installed NCG handling system and details are enumerated here.

Typical NCG compounds

The main odour causing compounds identified are Hydrogen Sulphide (H_2S), Methyl Mercaptans (MM), Dimethyl Sulphide (DMS) and Dimethyl Disulphide (DMDS). Sulphide is present in white liquor in the form of Na_2S and some of it is released during cooking as above compounds. MM and DMS are formed during the cooking when methoxyl groups of lignin reacts with HS- (Hydosulphide ion).

The unpleasant smell of the compounds can be sensed by human beings. Bad smell and toxicity

Table 1 Prperties of odour emitting compounds

Component	Lower Explosive Limit (% V)	Upper Explosive Limit (% V)	Auto-ignition Temper-ature (°C)
H_2S	4.3	45.0	260
M M	3.9	21.8	340
DMS	2.2	19.7	206
DMDS	1.1	8.0	300

are not only negative properties but they are also very explosive and corrosive at certain concentrations when mixed with air. All components of NCG are considered explosive in the concentration range of 1%- 45% (by volume). Typical data on auto ignition temperatures of different sulphide compounds are given in Table 1.

NCG are highly corrosive to carbon steel. Hydrogen sulphide and methyl mercaptans will be absorbed in the condensate and forms acidic condensate. Hence carbon steel should not be used in NCG collection system. Components of NCG are powerful solvents. Therefore use of plastics or FRP should be avoided. Stainless steel of 300 series proved to be corrosion resistant to NCG.

NCG handling system before modification

Strong NCG from Evaporator plant are fed to scrubbers where they are scrubbed with white liquor of 85°C and there after unabsorbed gasses are released to the atmosphere. NCG from cooking (Degassing gases) are let to scrubbers that also operate with white liquor. Gases from condensers of blow heat recovery system are directly let to air.

Strong NCG measurements

Overseas consultants were engaged for measurement and analysis of strong NCG and suggest suitable scheme for handling the same. Accordingly NCG samples were collected in special plastic pack to analyze concentrations of H_2S, MM and DMS. DMDS concentration was estimated based on typical values normally found in strong NCG.

Table 2

Component	Unit	Value
H_2S	%	1.08
M M	%	2.29
DMS	%	2.09
DMDS	%	0.92
Air	%	92.84

The samples were pumped by vacuum pump to the ice water cooled heat exchanger to condense all water vapour. Temperature of gas sampled was 10-20°C after sampling. Flow rate was measured by pitot tube and pressure difference meter. Temperature was measured by digital thermometer.

The average flow of NCG from evaporators and digesters varied in the range of 39.2 NM3 to 14.6 NM^3/T of pulp. Analysis of strong NCG without scrubbing is given in the table given below:

Actions suggested for handling strong NCG

a) The first step required is the collection of strong NCG from evaporation and digester area by laying separate lines to incineration area.

b) Evaporator plant NCG without white liquor scrubber has too high temperature. The higher temperature gases have to be cooled down by a condenser or by WL scrubbing. WL scrubber besides cooling the gases to about 85°C also absorbs some sulphur compounds and is more beneficial. Removal of extra water vapour due to scrubbing is to be done just before incineration.

c) The NCG from cooking plant (degassing gasses in the beginning of cooking) is also at high temperature. These are also to be passed through WL scrubber for absorbing sulphur compounds and reducing the temperature. These gases along with NCG from digester (blow vapours from condensers) are to be collected and transported in one pipeline.

d) Incineration can be carried out in limekiln or recovery boiler or dedicated incinerator. As the existing recovery boiler metallurgy is not suitable for handling NCG, it is recomnended to incinerate in limekiln, direct flare up or dedicated incinerator.

Description of the installed NCG handling system

NCG from Evaporator plant

NCG from evaporators are passed through a shell and tube heat exchanger to remove all the

vapours prior to incineration. Mill water is used for condensing the vapours and outlet water is recirculated to cooling tower. Provision is made for collecting the NCG with or without scrubber in service. NCG are transported with the help of an ejector system in which LP steam is used as motive force. Provision is made for removing the condensate formed in the line with the help of condensate tanks and pumping system. NCG from ejector are passed through a droplet separator to remove water and a heater to raise the temperature to about 110°C to ensure no water entry into kiln and flame arrester.

NCG from Digester plant

NCG from digester degassing and blow/waste

Experience of APPM

Sl.No.	Name of the plant	Observations/ Experiences	Remarks/actions taken.
1.	Evaporator Plant	Removal of condensate from NCG.	* Laying of lines with slope. * Installation of the intermediate condensate removal system with tanks and pumps.
2.	Digester Plant	Release of NCG to atmosphere or dilution of NCG with air.	* Increasing the setting of safety valve from 500 mmwc to 700 mmwc helped to over come this problem. * Providing the pressure control for ejectors. * Installation of pressure control for waste heat recovery system condensers hood.
		Escape of NCG from degassing from BL/WL tanks particularly during blowing period.	* Connecting the NCG from degassing directly to cyclone separator. * Providing NRV in degassing NCG line.
3.	NCG incineration in lime kiln	Low temperature of NCG.	* Maintaining the desired steam pressure by installing a PRDS.
		Occasional ball formation in the kiln. High CO level in kiln flue gas.	* This was experienced earlier also and can not be attributed to NCG system only. * Providing a separate atr blower for NCG burner instead of air from kiln PA fan.
4.	Incineration in dedicated incinerator	High oil consumption	* Optimizing the waste heat recovery system at digesters to avoid condensable vapors with NCG. * Fine tuning of Oxygen level in flue gas.

heat recovery system are connected to a cyclone separator for removal of water particles. Provision is made for collecting the digester degassing NCG with or without scrubber in service. NCG are transported in a common line with the help of an ejector system in which LP steam is used as motive force. At the ejector out let similar arrangements for droplet separation and heating are made prior to incineration in lime kiln.

NCG burning in lime kiln

Strong NCG from both the sources is connected to a burner provided just above the existing burner of lime kiln. This NCG burner is provided with a cooling arrangement with air as medium of cooling. The NCG burning system is provided with all safety interlocks. The flame scanner shall monitor the lime kiln burner flame all the time and in case of any failure it gives command to vent the NCG to atmosphere. All the controls and logics are routed through a dedicated PLC based SCADA system and are displayed in the monitor located in the control room.

NCG burning in dedicated incinerator

During nonavailability of lime kiln NCG can be incinerated in a dedicated incinerator. The incinerator is a fire tube boiler. The dedicated boiler is equipped with a full fledged burner management system comprising of startup ignitor and fuel oil firing system. Ignition system is provided with gas as fuel. Atomization of fuel is through M.P. Steam. Dedicated fan is provided for supply of combustion air to burner. The flow of air is damper controlled based on the preset oxygen levels in the flue gas of incinerator. A dedicated feed water tank is kept at boiler with one hour storage capacity. Boiler exhaust gases

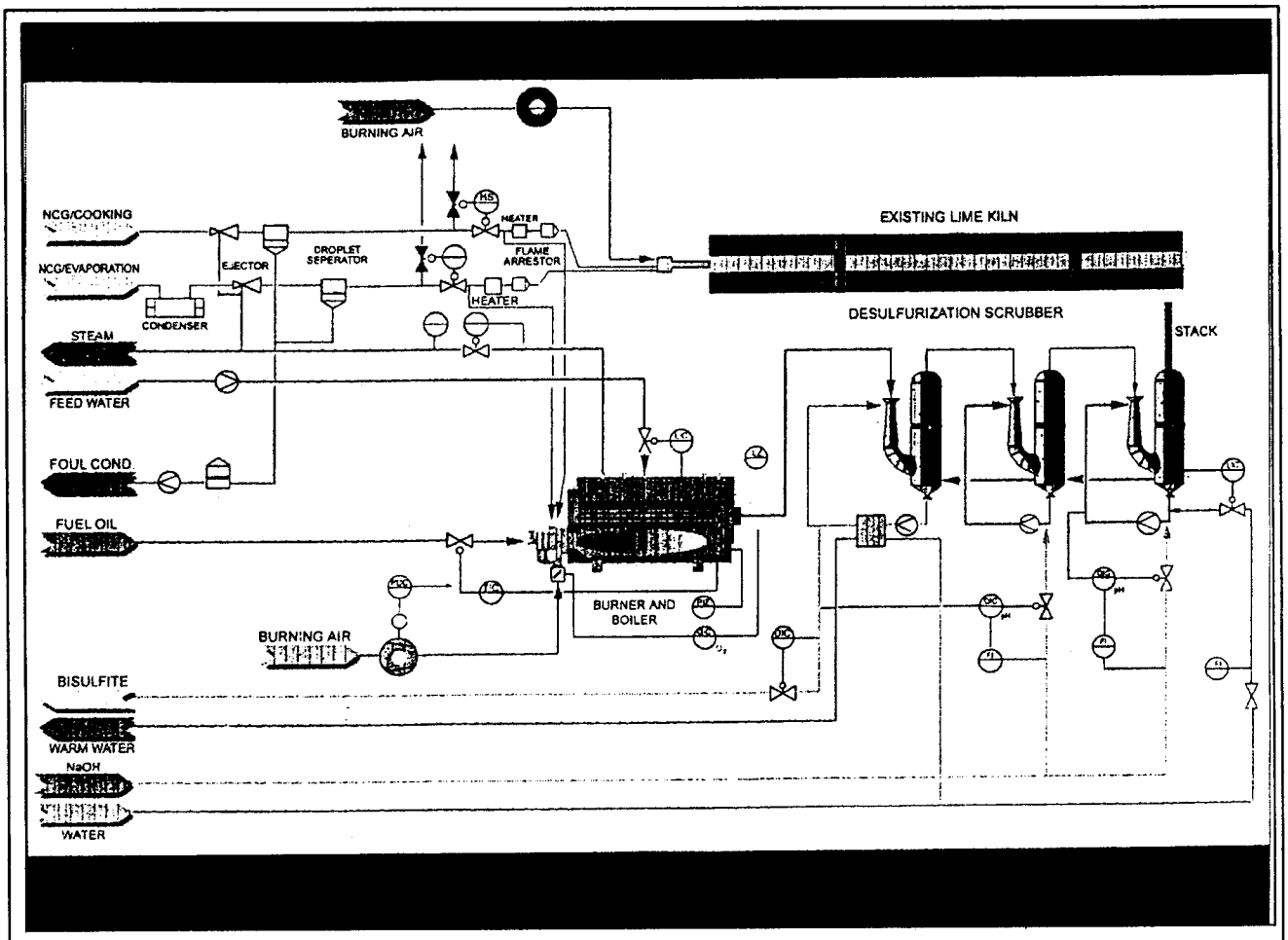

Fig.1. APPM NCG Handling System

Table 2. NCG Measurement in nearby locations by the Mill

Location	Distance from Mills	Before NCG PPM (Ave.)	After NCG PPM (Ave.)
a) Muncipal Corporation of Rajahmundry office	2.5 KM South	BDL	BDL
b) Brothern Church	Opposite	14.5	BDL
c) Mallayapeta	1.5KM North	9.0	BDL
d) Prakashnagar	3KM East	2.4	BDL
e) Vidyanagar,	2KM East	BDL	BDL
f) Y -Junction -	1 KM East	BDL	BDL
Note: BDL - Below Detection Limits.			

are scrubbed with venturi scrubber system before letting out to atmosphere. A three stage counter current scrubbing system is provided with NaOH as scrubbing medium. pH of the circulating fluid is controlled by NaOH in take. The scrubbers are provided with level and density control systems.

Project implementation

Study and measurement of NCG is carried out in September 2000. Detailed report with recommendations was submitted in January 2001. Required equipments were ordered in February 2002. Incineration in lime kiln was commissioned in September, 2002 and incineration in dedicated incinerator was started by end November, 2002. Cost of installation of the total project is Rs. 500 lacs. Approximate annual operating cost for incineration in lime kiln is Rs. 30 lacs and for the dedicated incinerator is Rs. 200 lacs.

Performance of the system

Testing of the ambient air quality for Methyl Mercaptans was carried out by an external agency around the Mills area at seven locations prior to and after installation of NCG handling system. Details are given.

A general feeling of the public in the neighboring areas is found to be no odor after installation of NCG handling system.

CONCLUSION

As an effort for cleaner environment NCG handling system, first of its kind in Indian pulp and paper industry was installed. by APPM. With adequate care in selecting suitable system,. and it's successful operation cleaner environment was achieved though it involved considerable capital investment and operating cost too.