

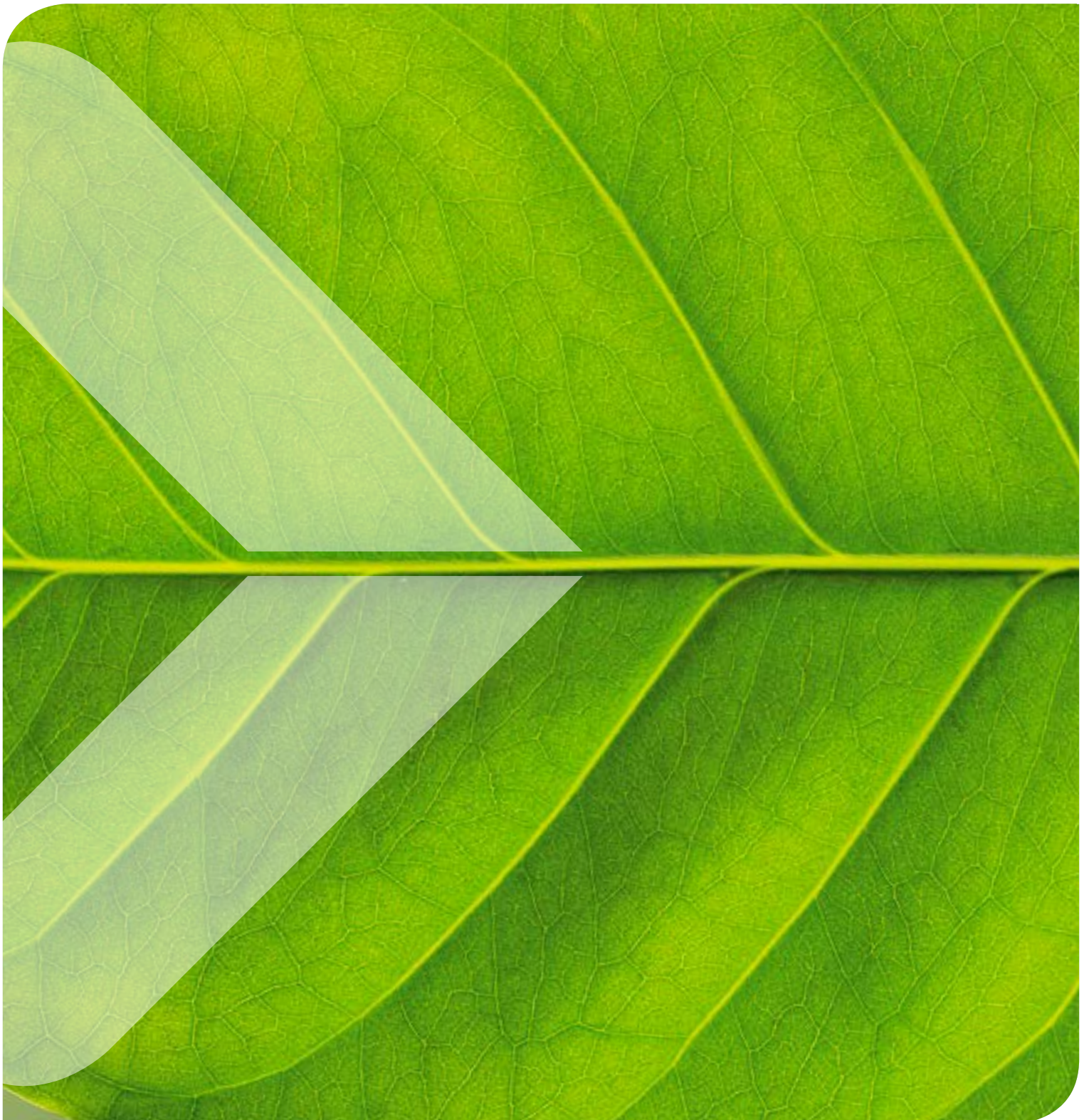
Odorless Pulp Mill

Victorious Installation

Odorless Pulp Mill in Successful Operation

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Picture 1; CMPC Guaiba Mill

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Abstract:

The sulphur in the cooking process can result in bad odor in the surroundings of a Kraft pulp mill. Together with the odor, sulphur compounds can also be an environmental problem, since they are released to the atmosphere. Although sulphur emissions are becoming lower as mills are upgraded, odors have continued to be a problem for people living close to the mills, because of the very low odor threshold.

Valmet has delivered a unique, practically odorless mill to CMPC Riograndese Ltda in Guaiba Brazil. The design guidelines were not to vent odorous gases and to aim for zero smells. The gas handling system collects and controls odors from more than 100 sources and all process areas are included. Incineration of non-condensable gases is ensured through multiple, simultaneously available incineration locations. According to CMPC it can be said that the system availability is practically 100% and there is always a system ready to handle NCG and prevent gases from being emitted to the atmosphere.

This paper describes the emphasis CMPC placed in the concept of the odorless mill in Guaiba and its surroundings and outlines the chosen technical solutions to achieve this target. The paper emphasizes the necessity of ensuring that odorous gases are treated also in shutdown and emergency situations, and explains how this has been achieved at the mill.

Keywords: pulp mill, odorless, sulphur compounds, NCG

Background

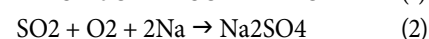
No venting of odorous gases and a “zero smell” pulp mill. That was the target that Valmet and CMPC started to aim for in year 2011 when the Guaiba line 2 project started. Odors from pulp mills have been a significant challenge globally during the last years, and mills have investigated ways to minimize odors with the ultimate goal of a totally odorless mill. The target in this project was not easy. There already was a pulp production line no 1 in operation in Guaiba, and to achieve a totally odorless mill, the systems in the existing mill needed to be upgraded. Moreover, the operability and availability of the gas handling system had to be state of the art. that authorities force the mill to shut down until the system is improved. This means that even though it may be difficult to calculate a payback time for the investment, in

many cases other consequences act as a driving force.

The main reason for aiming to make a mill odorless is naturally the people who work at the mill and, more importantly, those who live nearby. Odor threshold for different components of non-condensable gases is very low, it varies between 0,001-0,01 ppm (see table 1). The other reason is, of course, emissions to the atmosphere. In pulp mills, the odorous emissions mean sulphur emissions, since the odor comes from TRS (Total Reduced Sulphur) compounds. The sulphur compounds originate from the cooking process and cannot be eliminated there at the source. The only solution is to collect and treat the sulphur containing gases safely and effectively.

Normally CNCG's are incinerated in recovery boilers, where TRS components

are oxidized into SO₂ and converted to Na₂SO₄ (Eq 1 and 2) During guarantee measurements in Guaiba TRS emission from recovery boiler stack was 0,4 mg/m³n @ 8% O₂ and SO₂ emission 0,1 mg/m³n @ 8% O₂. This shows that the oxidation and sulphur conversion from gas phase to ash in recovery boiler is extremely efficient.



Nowadays the worst case scenario with an inadequate NCG (Non-Condensable Gas) treatment system is that authorities force the mill to shut down until the system is improved. This means that even though it may be difficult to calculate a payback time for the investment, in many cases other consequences act as a driving force.

		Hydrogen sulphide	Methyl-mercaptan	Dimethyl sulphide	Dimethyl disulphide	Turpentine (α pinene)	Methanol
Formula		H ₂ S	CH ₃ SH	(CH ₃) ₂ S	(CH ₃) ₂ S ₂	C ₁₀ H ₁₆	CH ₃ OH
Molecular mass		34	48	64	94	132	32
Explosion limit	LEL	4,3	3,9	2,2	1,1	0,8	5,5
	UEL	45,0	21,8	19,7	16,1	6,0	36,5
Flame velocity	m/s			0,6		0,62	0,5
Auto-ignition temperature	°C	260	197 (340)	206,0	300	255	385 (465)
Flash point	°C	Gas	Gas	-49,0	24,0	34	11
Boiling point	°C	-60	6	38	110	150	65
Heat value HHV	MJ/kg	15	22	31	23	41	22
Volume weight of gas compared to air		1,19	0,87	2,14	3,24	4,70	1,11
Odour threshold	ppm	0.008	0.0004-0.003	0.001-0.01	0.003-0.011	100	100
Solubility in water		Yes	No	No	Poor	No	Yes

Table 1: Characteristics of different components of non-condensable gases in air [1], [2]

How can a mill become odorless?

The first step is to identify all sources of odorous gases. There are two different kinds; DNCG's (Diluted Non Condensable Gases) and CNCG's (Concentrated Non Condensable Gases). DNCG's are collected from atmospheric sources at evaporation plant, white liquor plant, cooking and fibre line areas. CNCG's are collected from pressurized sources at evaporation plant and fibre line. Both are considered dangerous due to their explosive and toxic nature at certain concentrations. DNCG flows are substantial but the TRS content is fairly low, according to Finnish recovery boiler committee [2] recommended maximum TRS concentration before incineration is below 200 ppm. The CNCG's on the other hand have a lower flow but the TRS content is high, according to Finnish recovery boiler committee [2] depending on the component in question even as high as 190 000 ppm, and this also gives them a very strong odor. To make the mill odorless, all tanks and equipment that produce DNCG's or CNCG's must be included in the gas collection system and the gases must be treated. This includes also recovery boiler dissolving tank vent gases and ash mixing tank vent gases.

After identification of all sources in Guaiba, a concept was created for the collection and overall gas handling system. To be able to ensure that no vents occur for any reason, multiple incineration locations are needed and at least some of them need to be in stand-by mode. The Guaiba recovery boilers would be the main incineration locations for DNCG's from the evaporation plant and fiber line areas. White liquor plant DNCG's would be treated separately and incinerated in lime kilns 1 and 2. The concept of the DNCG overall concept is shown in picture 2.

For CNCG's the system became extremely complex, since all odor emissions had to be prevented. See picture 3 for the CNCG incineration concept.

Operational reliability and safety of the incineration concept

When the incineration concept was chosen, a decision had to be made on the criticality of the odor issue. A few questions were how high the costs would be if some of the incineration locations would be on stand-by at all times and how much CMPC was willing to invest on this issue. It was clear that no CNCG's could be released to atmosphere at any time, no matter what the cost. The availability of the system was seen as very important and shutting down the mill was considered to be the ultimate means to prevent odorous emissions, but this had to be avoided as much as possible.

First of all, this meant that the system had to be designed to handle gases at all incineration locations at all times by keeping CNCG lines constantly hot using steam. Keeping the CNCG lines hot prevents buildup of condensates that can produce pressure interlocking and trip the burner before the incineration even starts. Another way to increase the availability of the CNCG system was to duplicate the critical instruments, such as level switches. If collection of foul condensate is interrupted, level interlocks at the droplet separators will stop the incineration to ensure system safety.

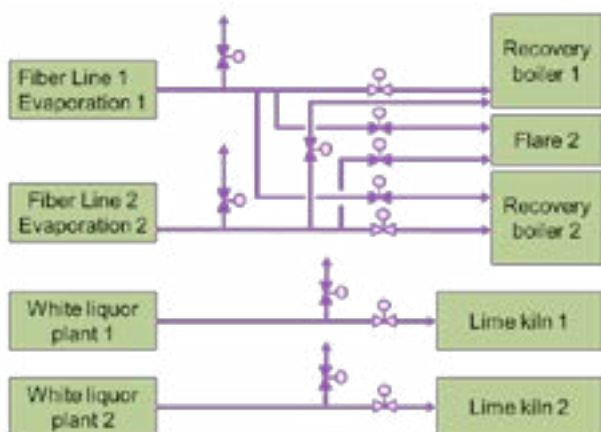
To prevent vents from occurring for any reason, the CNCG system can withstand pressure up to even 1 bar(g) to enable "bottling up" of gases. This means that on-off valves can be simultaneously closed towards all incineration locations whilst gas is stored inside piping. During this period pressure starts to rise, but by carefully designing all CNCG related piping it is possible to ensure uninterrupted gas treatment and switching between incineration locations without opening the high vent at any circumstance. For safety reasons, the CNCG high vent still remains as a part of the system, but it is only used in a case of emergency to protect the system from, for example, too high pressure. At all other times, the system shuts down and the production of CNCC's is stopped rather than venting the gases to the atmosphere. High vent is not even used during flushing of the CNCG lines with steam. During evaporation plant start-

up, the air inside evaporation train piping is flushed to the flare burner. All CNCG distribution systems were designed to be identical to make it easy for the operators to operate them. This also enabled the use of identical spare parts for key components. One operator is dedicated for the NCG system at all times to ensure that a skilled person is always in responsible of the system operation.

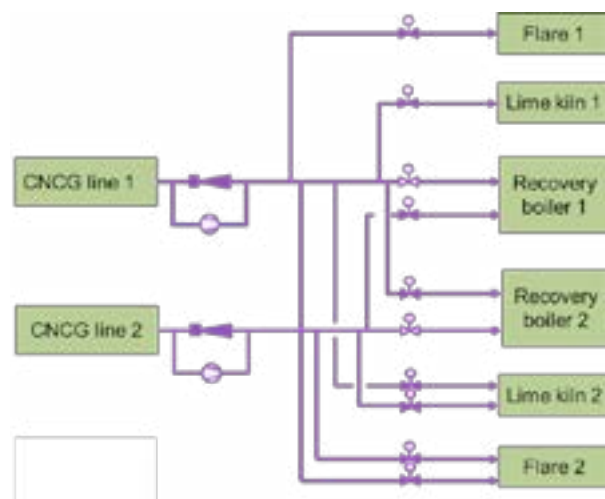
In order to further minimize SO₂ emissions, a part of the TRS components are washed away in a TRS scrubber prior to incineration in certain situations. These situations include the diverting of the CNCG's to the lime kiln burner or the flare burner, and the simultaneous burning of the CNCG's of both lines (G1 and G2) in only one of the recovery boilers (trip or stop of the other recovery boiler).

Other measures to minimize odor

All possible measures were taken to minimize odor, and special attention was paid to the condensate collection systems. Disturbances because of accumulation of condensate should be minimized and, on the other hand, the possibility of having a misdirected flow of gases because of empty water seals should be avoided. The system for collection of foul condensate became really extensive. Special attention was paid to CNCG foul condensate piping design, condensate removal points and



Picture 2; DNCG incineration concept



Picture 3; CNCG incineration concept

inclinations of piping to ensure that all condensate is safely transferred to pumping tanks and further to foul condensate tank.

After the normal operation conditions and most common disturbances had been taken into account, the blackout situations and annual mill shutdowns were next. It is clear that even though the mill shuts down for some reason (no electricity, annual shutdown) the tanks will still continue to produce odorous gases until emptied and flushed. Annual shutdown procedures were easy to determine, since this is a planned shutdown. The decision was to keep the new flare burner no 2 in operation until the mill starts up again and other incineration locations are again available. Normal maintenance for flare no 2 will be done during mill operation. Unexpected blackouts were more difficult to prepare for since vents are not allowed at any circumstance.

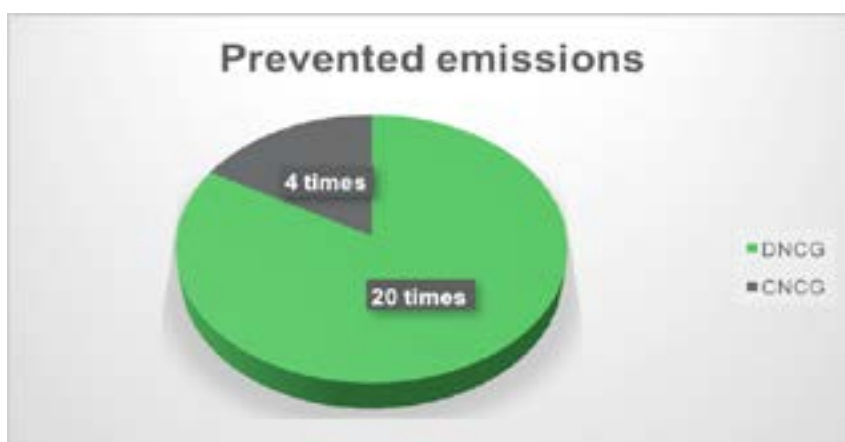
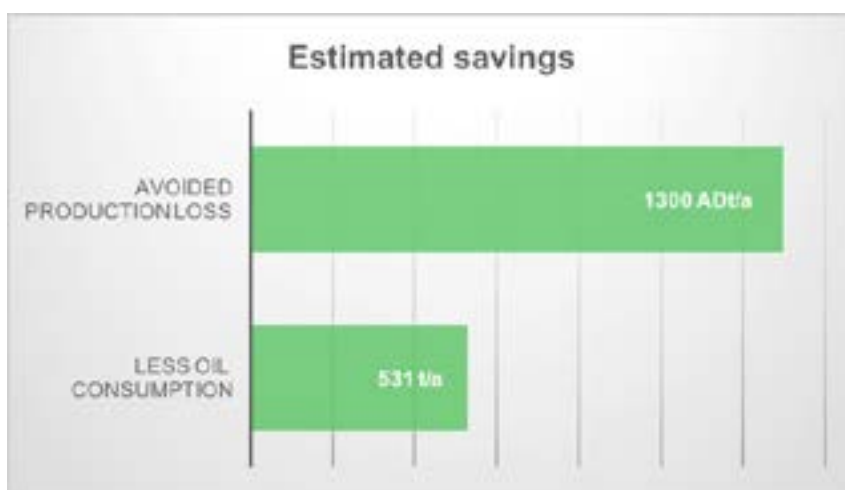
At least one of the incineration locations had to be in operation even during situations when there is a power supply failure, mill water supply failure and/or failure of instrument air. The CNCG collection had to be ensured even in case of a failure in steam supply, so a vacuum pump was installed in parallel with the steam ejector. Operability of the system was ensured by connecting critical components, such as the vacuum pump, to an uninterrupted power supply (UPS). Critical instruments were also connected to the UPS and the combustion air fan for the flare was connected to a diesel rotary uninterruptible power supply (DRUPS). It was also necessary to ensure system operation in the case of a failure or a temporary shutdown of the DCS (Distributed Control System) on line 1 or line 2. The DCS operability was ensured by having own process stations for NCG's in the DCS, and the dedicated DCS electricity was ensured by uninterruptible power supply (UPS).

For DNCG's, the concept was lighter. During normal operation, the DNCG's of the white liquor plant are lead to lime kilns. During disturbances they will be taken to the atmosphere, since the odor emissions are low. During

recovery boiler outages (either RB1 or RB2), fiber line and evaporation plant gases can be diverted to the other recovery boiler still in operation. If both recovery boilers are simultaneously out of operation, all line 1 DNCG's and evaporation plant DNCG's from line 2 will be incinerated in flare no 2. This is because evaporation plant gases are the most odorous DNCG's. At a blackout, other sources either stop (like pulp washers) or produce less odor (such as tanks that contain cooler liquids) so line 2 DNCG's from fiber line will be lead to a 150 m high stack. If for some reason flare no 2 is not available for DNCG incineration, both lines will divert DNCG's to 150 m high stacks.

Operational Experiences

Judging from the mill start-up, the results have been more than promising. Before the implementation of the new NCG system, the Guaiba mill used a separate incinerator for incineration of NCG's. The diesel oil consumption of the incinerator was around 1.5 tons per day. Now gases are burned in recovery boilers, and estimated savings in oil consumption are approximately 530 tons per year. Earlier, the NCG incineration concept was to shut down the mill when the NCG incinerator could not take the gases. This meant production losses of about 1 300 Adt of pulp per year. Nowadays, the NCG's can always be directed to one of several incineration locations.



Conclusions

The world is changing and environmental issues are continuously becoming more and more important. This has been one of the drivers for companies to improve NCG systems and develop new concepts to handle odorous gases. In CMPC Guaiba an odorless pulp mill has now been running for almost two years. Besides reducing emissions and preventing explosions, the installation also contains many safety aspects that provide a safe working environment for the personnel at the pulp mill. CMPC Guaiba is an odorless mill without compromising safety!

Valmet's professionals around the world work close to our customers and are committed to moving our customer's performance forward – every day.



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