FOUL CONDENSATE STRIPPING

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INTRODUCTION

Foul condensates from the digesters and evaporators contain organic compounds, such as methanol (MeOH) and turpentine, as well as reduced sulfur compounds. These contribute greatly to pulp mill water pollution in the form of Biochemical Oxygen Demand (BOD) and toxicity, and air pollution in the form of Volatile Organic Compounds (VOC), and odor.

For this reason, foul condensates are often collected and treated by stripping, using either air or steam, to remove these volatile pollutants. In many cases, the collected pollutants can be economically used as a fossil fuel substitute.

This paper will cover the condensates that are collected, various stripping methods, types of stripping columns, basic theory, operating problems, operating procedures, and disposal of the stripper off-gas (SOG) that contains the removed pollutants.

In the United States regulations resulting from the Clean Air Act Amendments (CAAA) of 1990, require the collection and treatment of "Kraft process condensates", better know as foul condensates or combined condensates.

Steam stripping is one of the treatments accepted by the U.S. Environmental Protection Agency (EPA). Other acceptable methods are hard piping to biological treatment, reusing the condensates in a process where the vents are collected and incinerated, or any other process that can meet the required removal and destruction efficiencies.

Although the rules allow various methods of determining removal efficiencies, bleached mills are required to collect selected condensates and treat them to destroy at least 10.2 pounds of methanol per oven dry ton of pulp (ODTP) (5.1 kilograms per oven dry megagram of pulp). Unbleached mills have to destroy at least 6.6 pounds per ODTP (3.3 kg/Mg).

Most mills built or upgraded since 1980 have had a condensate stripping system installed as an integral part of the overall mill process. Many older mills have now added a foul condensate stripper to meet various environmental regulations.

To minimize the cost of the stripping system while complying with treatment requirements, efforts are made to minimize the volume of condensate to be stripped and to integrate the stripping system with other equipment such as evaporators.

WHY STRIP FOUL CONDENSATES?

The prime reason for stripping foul condensates is pollution control. Foul condensates can contain 14 to 20 lb (7 to 10 kg) BOD, 2 to 4 lb (1 to 2 kg) turpentine and 2 to 4 lb (1 to 2 kg) TRS per ton (tonne) of pulp (Table 1).

If these foul condensates are untreated, they cannot be reused in the mill and are sewered, putting a high load of BOD and toxicity into the secondary treatment system and frequently causing air pollution problems, as the TRS and methanol is released to the atmosphere by flashing from open sewers.

By collecting these foul condensates and stripping them, most of the pollutants can be removed and burned, reducing the pollution load to the air and to the secondary treatment system.

In most cases, the stripped condensates can be reused in the mill for such purposes as brown stock washing and make-up water in the recausticizing area. Thus, stripping also has the potential to reduce the total mill water demand. Stripping will be an integral part of the effluent free mill of the future.

Fortunately, the stripped compounds are easily burned. Heat of combustion values for stripper overheads on the order of 120,000 Kcal/tonne (475,000 BTU/Ton) pulp have been reported (Table 2).

These stripper overheads can be transported as a gas, or condensed and transported as a liquid and used to replace fossil fuel in lime kilns, boilers and incinerators. The liquid stripper product may also be blended with heavy black liquor and fired into the recovery boiler. In most cases, the net heat released by burning these pollutants is greater than the heat energy required to operate the stripper, and can be used to help economically justify installing the stripping system.

Table 1: Typical Pollutant Loads in Foul Condensates
Bleached Kraft Mill
Based on Unbleached Digester Production

Source	Total Flow		Methanol		Turpentine		TRS	
	kg/tonne	lb/tonne	kg/t	lb/t	kg/t	lb/t	kg/t	lb/t
Batch Digester Mill (Softwood)								
Digester accumulator overflow	1125	2250	4.0	8.0	0.50	1.0	0.20	0.40
Turpentine decanter underflow	250	500	1.5	3.0	0.50	1.0	0.15	0.30
Total evaporator condensate	7000	14,000	4.2	8.4	0.25	0.5	1.00	2.00
Continuous Digester Mill (Softwood)								
Turpentine decanter underflow	450	900	2.5	5.0	0.50	1.0	0.12	0.24
Total evaporator condensate	8000	16,000	7.5	15.0	0.50	1.0	1.20	2.40

Table 2: Heat Value of Pollutants

Pollutant	Net Heat of Combustion	
	kgcal/kg	Btu/lb
MeOH	5037	9066
Alpha-pinene	9547	17,200
H_2S	3647	6565
CH_3SH	6229	11,212
CH_3SCH_3	7371	13,268
CH_3SSCH_3	5638	10,148

WHAT CONDENSATES ARE STRIPPED?

Regulations in the United States require collection and treatment of the condensates from the digester system, the turpentine recovery system, the evaporator systems, the HVLC (dilute NCG) collection system, and the LVHC (concentrated NCG) collection system.

To minimize the volume of condensate to be collected, segregation techniques are employed. Condensation of a contaminated vapor begins with the least volatile component, and then proceeds with succeeding components in order of their respective volatilities. The major components of interest in foul condensate stripping (in order of increasing volatility) are water, methanol, and TRS compounds. Therefore as foul vapor condenses, the first component to condense will be water with slight methanol contamination, then water with heavy methanol and TRS contamination.

Batch Digester Blow Steam Condensate

The condensates from condensed blow steam are rich in methanol and TRS. In order for these pollutants to be collected, however, the blow steam must be condensed in a controlled manner. If the blow steam condensing system is undersized or operated incorrectly, some of the blow steam may be vented to atmosphere with methanol and TRS vented as well.

In some mills, fresh water is added to the accumulator to keep the bottom temperature low. This dilution of the blow steam condensate increases the volume of condensate to be collected and treated.

In a modern blow steam condensing system, the direct contact primary condenser is followed by an indirect secondary/tertiary condenser. It has been found that up to 70% of the pollutants can be "segregated" into the 15% of the blow steam that condenses in the secondary condenser. This concentration of the pollutants in a smaller volume of condensate greatly improves the economics of stripping.

Batch Digester Relief Steam

During the cook, non-condensable gases (NCG) are vented from the digester. The NCG carries with it considerable amounts of steam, methanol, and turpentine. This steam must be condensed in order to collect turpentine and prepare the remaining NCG for collection. The condensates so formed must be collected and treated. As above, this condensation can be done in two stages, and only the rich or segregated stream collected and treated.

Continuous Digester Flash Steam

During a continuous cook hot, pressurized liquor is removed from the digester and flashed to atmospheric pressure. The flash steam contains considerable amounts of NCG, methanol, and turpentine. This steam must be condensed in order to collect the turpentine and NCG. This condensation can also be done in two stages, and only the rich or segregated stream collected and treated.

Turpentine Decanter Underflow

In softwood mills batch digester relief steam condensates and continuous digester flash steam condensates go to a turpentine recovery system. The underflow from the turpentine decanter is a relatively low flow that is rich in methanol and TRS, making this foul condensate a prime candidate for stripping.

Evaporator Condensates

The combined foul condensates from the multiple effect evaporators contain methanol, turpentine and TRS removed from black liquor during evaporation. The evaporators, in effect, act as strippers to remove these pollutants from the black liquor.

Most of the pollutants will collect in the condensates of the evaporator effects and condensers following the effects where the weak black liquor is fed. For example, if weak black liquor is fed to effects 5 and 6 of a six-effect evaporator, the pollutants will be found in the condensates from the 6th effect and the surface condenser. These condensates may be selected for treatment, thus reducing the amount of evaporator condensate to be treated by about two thirds.

In modern multiple effect evaporators, especially those of the falling film design that have been supplied since 1980, the majority of the pollutants can be collected in 15% or less of the total condensate. This is commonly achieved by using two-stage condensing with internals that facilitate condensate segregation. This greatly reduces the condensate to be treated, and thus improves the efficiency and economics of stripping.

In general, there will be four condensate streams generated in a modern falling film evaporator. The first is clean steam condensate from the first effect. The second is combined condensates from the middle effects, and these will have methanol in the 100 ppm range. The third stream is contaminated condensates from the lean stream of segregated condensates from the feed effects, and these will have methanol concentrations in the range of 1000 ppm. The final stream is foul condensates from the rich stream of segregated condensates, and the methanol will be in the 5000 ppm range.

NCG System Condensates

The condensates formed in NCG systems, although small in volume, are very concentrated in methanol and TRS compounds, and contribute to odors in the mill area if drained into open sewers. Regulations require collection and treatment of these condensates.

METHODS OF STRIPPING

Stripping systems in Kraft pulp mills can use air or steam to strip contaminants from the condensates. The stripping systems can be designed for the removal of TRS only or for the removal of both TRS and methanol (BOD). TRS is easily stripped, whereas stripping methanol is more difficult, consequently making the

latter systems more costly and complex. Further, the CAAA regulations will not accept air stripping, or stripping for TRS only. The vast majority of stripping systems use steam and are designed to remove methanol from the condensates.

Air Stripping for TRS Removal

This is the most basic form of stripping and is generally used to remove TRS from condensates so that they do not create odor problems in the secondary treatment system (Figure 1). In this case, the foul condensates are stripped by air moving counter-currently in a stripper column.

About 3 - 5 weight % of air on condensate is required. This corresponds to an exit gas stream of about 1000 cfm (1400 m^3/hr) for each 100 gpm (379 lpm) of condensate treated. Higher air ratios may be necessary if the TRS concentration is high, in order that the stripped gases are well below the Lower Flammability Limit (LFL) in the overheads.

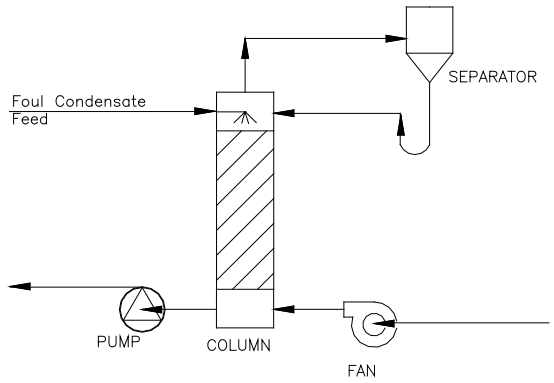


Figure 1. *Air Stripper for TRS*

The two factors which have the greatest effect on air stripper efficiency are temperature and pH (Figure 2). A pH of seven or less and a condensate temperature of 50°C (120 °F) or more are required for good stripping efficiency. Disposal of the high volume of warm moist overheads is the major disadvantage of this system.

Disposal is usually accomplished by burning in a boiler, kiln or incinerator. The advantages of this system are its simplicity and low cost, however the gas disposal is much more expensive.

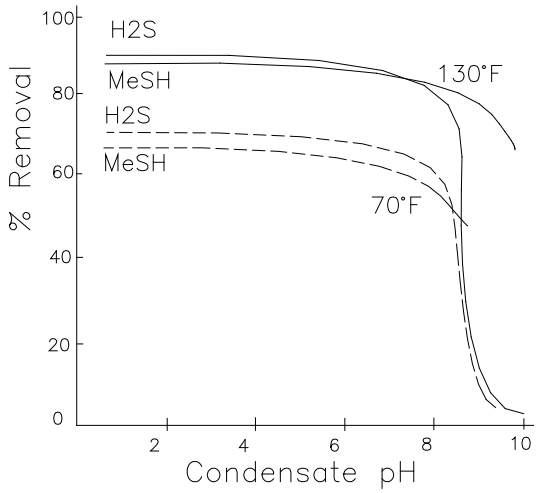


Figure 2. *Air Stripper Eficiency*

Air Stripping for BOD Removal

This system is similar to air stripping for TRS, except that much higher quantities of air are required, in the range of 16 - 20 weight % air on condensate. This corresponds to an exit gas stream of about 4000 cfm (5600 m^3/hr) for each 100 gpm (379 lpm) of condensate treated. Temperature is also very important and temperatures in excess of 70ºC (160°F) are required for good efficiency. This form of stripping is not practical, and is not practiced.

Steam Stripping for TRS Removal

This system is similar to the air stripper except that two heat exchangers are added to the system (Figure 3). It is necessary to preheat the foul condensate before stripping; otherwise the stripping steam is partially condensed by the cold condensate. This preheating of the feed condensate is typically accomplished by exchanging heat with the hot stripped condensate.

The second heat exchanger is used to condense the steam out of the stripped TRS gas before it is incinerated. The condensate is returned to the top of the stripping column. About 3 - 5 weight % of steam on condensate is required.

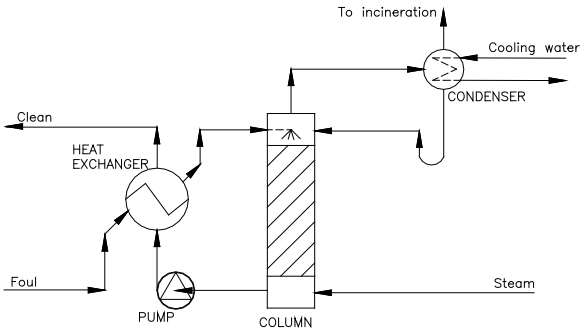


Figure 3. *Steam Stripper for TRS*

As with air stripping, efficiency is pH dependent. Despite the disadvantage of higher capital and operating cost, disposal of the overheads is much simpler and less costly. Operating costs can be reduced if some use can be made of the heat recovered in the overhead condenser.

Steam Stripping for BOD Removal

Steam stripping for BOD is the most commonly practiced method of condensate stripping. This system is similar to steam stripping for TRS except that the overhead condenser becomes a reflux condenser and the top section of the stripping column becomes a rectification column to concentrate the methanol (Figure 4). The steam requirement increases to 18 - 20 weight % steam on condensate (Figure 5).

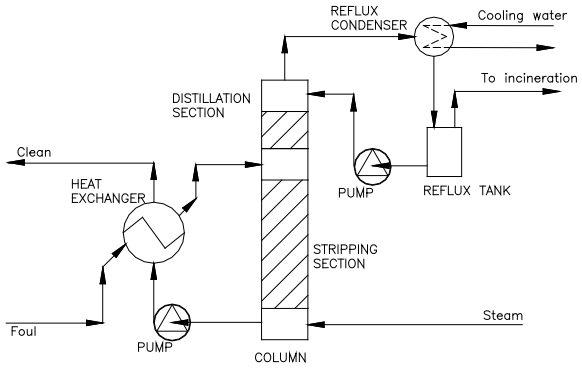


Figure 4. *Steam Stripper for B.O.D.*

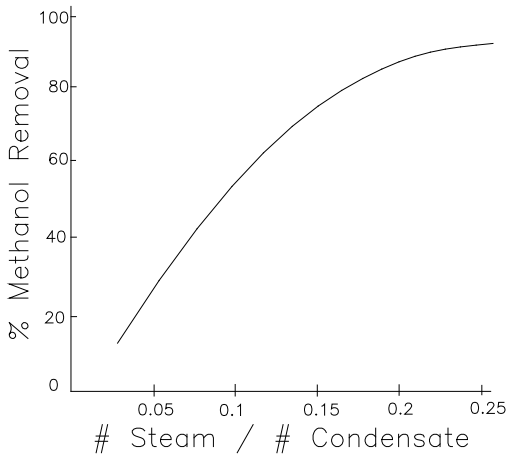


Figure 5. *Distillation Efficiency*

These systems have the advantage of high efficiency, producing an overhead product that is usable as a fuel. The major disadvantages are high capital and operating costs. The operating costs can be reduced if some use of the heat from the reflux condenser can be found such as preheating boiler feed water, making clean hot water for a bleach plant, heating black liquor, or generating low pressure steam for process use.

The reflux tank shown in Figure 4 is optional, and many systems do not have them. Instead, the reflux condenser may be positioned above the column, and reflux flows by gravity back to the column.

When fresh steam is added to a stripping column the steam condensate mixes with the foul condensate and cannot be returned to a clean condensate system. By adding a stripped condensate reboiler ahead of the stripper, fresh steam condensate can be recovered for reuse.

TYPES OF COLUMNS

In general, two types of columns are used for stripping; packed columns and valve tray columns.

Packed columns are generally less costly for small diameter columns. Packing material is stainless steel pall rings. The disadvantages of packed columns are poor turndown ratio and plugging of the packing by fiber and organics carried in the condensate.

Valve tray columns are an advanced form of a bubble cap tray column. They have the advantages of maintaining high efficiency over a wide operating range, a constant pressure drop at varying vapor load rates and self-cleaning of the trays.

As a general rule, packed columns are used for small TRS strippers and very small BOD strippers, while valve tray columns are used for large TRS and BOD strippers. The valve tray steam stripping column has become the standard for meeting environmental requirements.

INTEGRATED COLUMNS

In order to reduce the capital and operating costs of steam type BOD strippers, the stripping process can be integrated into a set of multiple effect evaporators. There are two basic ways to do this.

Fully Integrated

The stripping column is placed between two effects, usually the No. 1 and No. 2. Steam from the No. 1 effect is run through the stripper and then condensed in the No. 2 effect. The No. 2 effect acts as the reflux condenser, saving this capital cost. The stripping steam is essentially free.

Figure 6 is a schematic depicting a fully integrated stripping system.

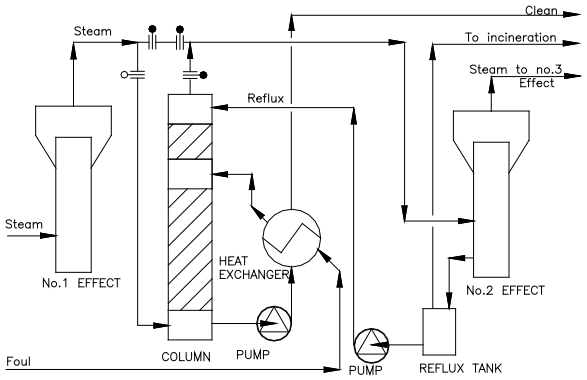


Figure 6. *Fully Integrated Column*

However, there is an efficiency loss of about 12% in the evaporators when the column is fully integrated. In a system of this type, for every Kcal or BTU lost by integration, two or more Kcals or BTUs are returned by the heat value from burning the stripped methanol.

This type of full integration with respect to the evaporators can be used when a stripper is integrated into an existing mill, and where condensate flows are high compared to the relative size of the evaporators.

Partially Integrated

In the case of a new mill with reduced foul condensate flows, and where the stripper is part of the initial evaporator design, only partial integration is required. Only part of the evaporator steam flow is used for stripping and the overheads are condensed in either an external preheater or in a dedicated internal section of a subsequent evaporator effect. Such systems have a much better energy return than fully integrated systems.

Figure 7 is an illustration of a partially integrated stripping system.

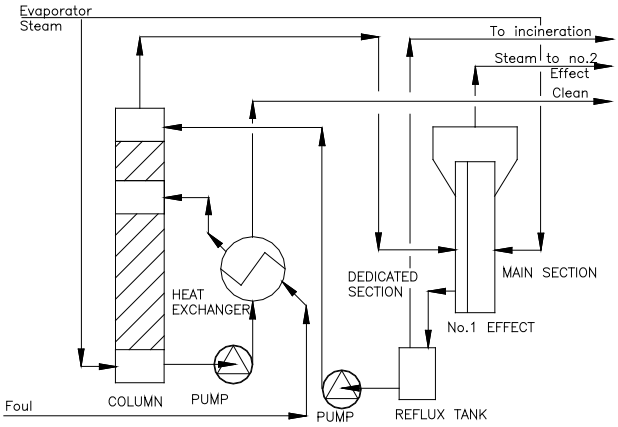


Figure 7. *Partially Integrated Column*

COLUMN OPERATION

Stripping systems are generally easy to operate although control schemes for strippers integrated into evaporators can be complex due to their dependence on evaporator operation. Some problems in column operation are as follows:

Foaming

Liquor in the foul condensate can cause the condensate to foam when air or steam is blown through it. This results in a flooded column where the condensate is carried out the top of the column and steam or air flow is blocked.

This problem is handled by measuring the conductivity of the foul condensate. A high conductivity indicates the presence of liquor and the condensate can be diverted before it gets to the column.

This problem may show up as loss of steam flow to the stripper, or high level in the reflux tank. The foam may also carry through the stripper off-gas (SOG) system and

into the incineration point, where it may extinguish the flame, or cause other damage.

Unstable Operation

In steam strippers where steam use is controlled and based on condensate flow, every change in flow upsets the system for several minutes. In a continuous change situation, such as if the condensate feed flow is based on level control of a foul condensate storage tank, the system remains unstable. Therefore, flow changes should be made on a stepwise basis and made as seldom as possible. In the case of an integrated column, the evaporator used should be run as smoothly as possible.

If a mill has more than one set of evaporators, the set with the stripper should carry a constant base load while the other set takes up the production rate changes. Unstable operation can also cause problems if the stripper gas is burned in a kiln or an incinerator. Pressure fluctuations can generate rapid changes in methanol concentration in the stripper product, and upset the heat balance in the kiln or incinerator.

Unstable operation will result in low stripping efficiency.

Steam Collapse

Once the column is started up, it is full of steam. If enough cold condensate enters the column, it will condense the steam where the cold condensate enters the column, causing an almost instantaneous high vacuum in the top of the column.

The hot condensate in the bottom of the column will boil rapidly, almost exploding. This sudden upward rush can buckle trays, pop them out of their hold down clips, or carry packing out of a packed column.

Such a situation can happen on a start-up when there is insufficient hot condensate in the bottom of the column to preheat the foul condensate. Great care must be taken to avoid such situations. Start-ups should be done very slowly.

Loss of trays results in loss of stripping efficiency, and significant downtime to repair trays.

Control of Contaminant Removal

Condensing in the reflux condenser must be controlled to maximize contaminant removal while minimizing steam loss. At this point in the process, the system is a very complex, two-phase, multi-component system, mainly made up of water, methanol, reduced sulfur gases and turpentine, and with several other compounds such as ethanol and acetone in lesser quantities.

Good control depends on a combination of pressure and temperature control in the reflux condenser. See REFLUX CONTROL below.

Fiber

The foul condensates tend to contain pulp fibers and these fibers can plug packed columns and heat exchangers, especially plate-type heat exchangers. Fortunately, valve tray columns are to some extent self-cleaning and less susceptible to fiber pluggage.

Fiber pluggage is typically minimized with the installation of an efficient fiber filter before the heat exchanger. Heat exchangers with wide gaps or large diameter tubes also help to avoid pluggage.

This problem normally shows up as loss of flow through the heat exchangers, especially in plate type heat exchangers, or in flooding on the trays just below the condensate inlet.

Plugging of Heat Exchangers

Several mills have experienced fouling on the stripped condensate side of the heat exchanger. Analyses show that the fouling material contains terpene-type compounds and lignin, and it is very difficult to remove. The fouling tendency increases with the stripper operating temperature and pressure.

This problem usually shows up as decreasing heat exchange efficiency and eventually loss of flow of the stripper bottoms, or high level in the bottom of the stripper.

As the heat exchanger becomes less efficient, more steam is consumed in heating the condensate to the column temperature, leaving less effective stripping steam and resulting in low methanol removal efficiency.

Several types of exchangers have been used to mitigate this problem, including shell and tube, plate and frame, spiral exchangers, and welded plate.

Attempts to chemically remove the scale have met with mixed success. To be effective, chemical cleaning must be done on a regular basis and before the heat exchange surfaces are too severely scaled.

Mechanical cleaning and hydroblasting is more effective than chemical cleaning, however access to the exchange surfaces is necessary. For this reason, the stripped

condensate should go through the tube side of shell and tube heat exchangers, to facilitate mechanical cleaning. Plate and frame exchangers with narrow passages can plug quickly and are costly to clean. Spiral exchangers will plug more slowly, but are also costly to clean. Spiral exchangers allow relatively easy access to both sides of the heat exchange surfaces to facilitate cleaning. Welded plate exchangers are a more recent solution, offering the best access for cleaning.

A recent innovation that shows promising results is a two-stage flash preheater. In each stage, the stripped condensate is flashed in a flash tank and the vapor condensed on the shellside of a shell and tube condenser. Foul condensate is heated inside the condenser tubes. Because the initial cooling of the stripped condensate does not occur on a heat exchange surface, the shellside of the condenser does not tend to foul.

Inorganic fouling can be minimized by keeping fresh or "hard" water out of the condensate steams entering the stripping system. Only condensates should be stripped. If inorganic scale is observed, the sources of the condensate streams should be examined to eliminate fresh water intrusion.

Turpentine in Storage Tank

As there is turpentine in the condensates, there is a tendency for the turpentine to decant in the storage tank, and collect on top of the condensates. If this happens, and the storage tank level drops, it is possible to send a slug of turpentine into the stripper.

The turpentine will easily strip, and the turpentine will go through the SOG system, and can cause problems at the incineration point, usually a sudden high temperature and low oxygen condition.

There are both safety and operational consequences of turpentine floating on the condensate surface. There are several means to minimize the turpentine build up in the storage tank. The first is to send the turpentine decanter underflow, and other streams which can be rich in turpentine, directly to the suction of the stripper feed pump, bypassing the tank.

Skimming the turpentine can also be performed. This can either be done periodically, returning the turpentine to the turpentine recovery system, or by continuously skimming of the turpentine into the stripper feed condensate.

REFLUX CONTROL

As mentioned above, good control of the reflux cycle is required to operate the stripper efficiently, both with respect to contaminant removal and heat recovery.

For any given operating pressure, and any desired stripper off-gas (SOG) concentration there is fixed equilibrium temperature. Operating at the proper equilibrium temperature and pressure is necessary in order to control the overhead composition.

Further, operating at the proper equilibrium conditions will ensure removal of the terpenes and red oils with the SOG, so that they can be subsequently burned. If the reflux condensate is allowed to sub cool, the terpenes and red oils will separate from the condensate, and build up in the reflux cycle until they cause control problems. This may also require the use of a reflux decanter.

The concentration of methanol in the SOG is a compromise between stripping efficiency and heat recovery. At higher methanol concentrations, heat recovery improves, but stripping efficiency declines. At lower methanol concentrations, stripping efficiency improves, but heat recovery declines. The generally accepted optimum methanol concentration in the overheads is 50% by weight. At constant methanol removal, a product concentration of 10% methanol carries with it nine times more water vapor to incineration than a 50% methanol product would contain.

In a non-integrated stripper, it is possible to control both the pressure and the temperature. Two methods of doing this are shown in Figures 8A and 8B.

With an integrated stripper, the evaporator operation will fix the stripping temperature. Thus it is necessary to control the operating pressure based on this temperature.

Temperature control is accomplished by controlling the cooling fluid flow through the reflux condenser. Pressure control is accomplished by controlling the back pressure on the SOG line.

In the scheme shown in Figure 8A, the temperature of the reflux condensate is measured rather than the temperature of the gas, which gives better response to temperature changes. This assumes that the condensate is not sub-cooled, and is at the equilibrium temperature. The condenser is mounted horizontally in order to minimize sub-cooling of the condensate. This scheme works well at design conditions, but sub-cooling tends to occur at reduced operating rates. Sub-cooling will also reduce the effective stripping steam, because the reflux

condensate will have to be reheated to the column operating temperature.

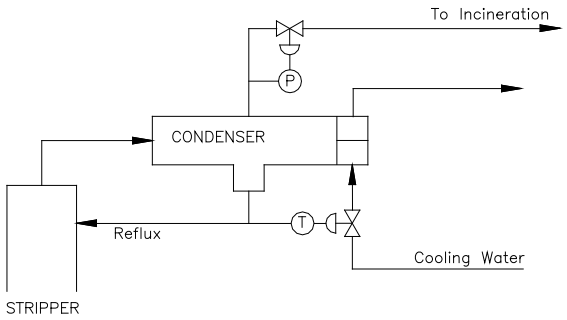


Figure 8A. *Reflux Control*

In the scheme shown in figure 8B, the overhead gas temperature is measured directly. Vapor from the reflux condenser is bubbled through the condensate in the reflux tank, which ensures that liquid and gas phases are in equilibrium. This gives slightly better control, but at a capital cost penalty. Turpentine accumulation in the reflux tank can also cause handling difficulties.

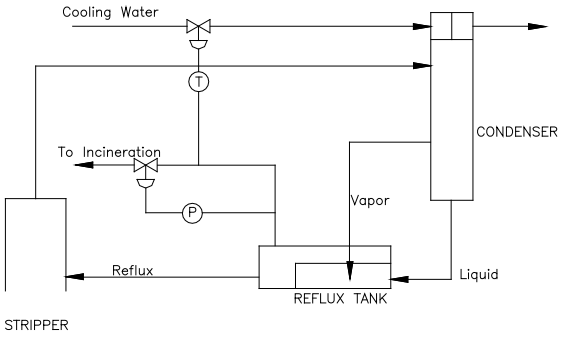


Figure 8B. *Reflux Control*

TRANSPORT AND DISPOSAL OF CONTAMINANTS

Once the contaminants have been stripped out of the condensate and removed from the system, they must be disposed of. The most common way to do this is to carry them in gaseous form and burn them directly in a kiln, boiler or separate incinerator. The system for transport is almost identical to a concentrated or, low volume, high concentration (LVHC) non-condensable gas (NCG) system. See Figure 9.

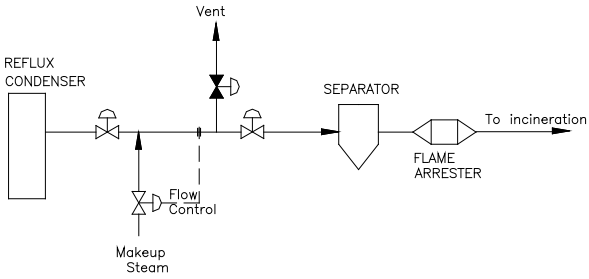


Figure 9. *Stripper Off Gas System*

One difference from a concentrated NCG system is that the stripper gas system requires makeup steam to ensure purging of the entire system on start-up and to ensure a minimum safe velocity in the line to the incineration point at all times. This is accomplished by measuring the line velocity near the incineration point and adding makeup steam, as necessary, near the pressure control valve at the stripper. The entire line must be insulated. The stripper gas system should be operating, with SOG or steam going to incineration, before any foul condensate is sent to the stripper.

The advantages of burning stripper overheads are low cost, simple operation, and recovery of the high fuel value of the contaminants.

The major disadvantage of burning as a vapor is that if this stream is ever vented, it will create a severe odor problem in the local area very quickly. Most newer systems are designed without atmospheric vents, and the stripping system is effectively shut down rather than vented to the atmosphere.

A second disadvantage of burning the stripper overheads as a vapor is that any fluctuation of the temperature or pressure in the stripping system will cause tremendous and instantaneous fluctuations in the heat value of the overhead stream, causing upsets at the incineration point.

It is also possible to collect the SOG as a liquid by use of an additional condenser. This allows for storage of the contaminants as a liquid, which can subsequently be used for fuel. There are capital cost and operational advantages to handling the liquid fuel. The small volume of liquefied methanol allows it to be stored in a tank where it blends into a uniform fuel. There is surge capacity in the storage tank. The liquid requires small lines for transport. It can be sprayed into a kiln, boiler or incinerator, or it can be blended with heavy black liquor and fired in a recovery boiler.

In some cases, the SOG will be further rectified to increase the methanol concentration to 80 to 90% by weight, however at significant additional cost.

A process to produce purified methanol from the stripper overheads has recently been developed. The methanol is recovered by separating it from water and other contaminants through distillation, producing a methanol product at a minimum of 99.85 wt % purity. The purified methanol could be used within the mill for the production of chlorine dioxide with the balance available for external sale.

When ammonia is generated in the cooking process it tends to accumulate in foul condensate streams. The standard stripping system transfers most of this ammonia into the stripper product. When subsequently burned a portion of the ammonia will be converted to NOx in the combustion products. The amount of NOx generated is a function of the type of incineration process and equipment used.

PROPER OPERATING PROCEDURES

A variety of procedures have been developed to reduce the possibility of steam collapse, and to eliminate venting of SOG during start-up and shutdown.

For stand-alone strippers condensate flow to the column is generally started before adding steam, and steam is stopped before the condensate flow is stopped.

Stripping systems integrated with evaporators do not always have the luxury of stopping the steam flow, so care must be taken to add condensate very slowly to prevent collapsing the steam. An example of such a procedure follows:

If the stripper is started up with steam, once the stripper is fully heated and all air purged out of the system by cracking open the backpressure control valve, feeding of condensate can begin. At a minimum steam flow of about 20% of design, start with a condensate flow of about 10% of design.

After five minutes, increase condensate flow to 20% of design. Continue to increase both condensate and steam flow in 10% increments every five minutes until the full operating rate is achieved.

The slow start-up will prevent damage to the trays due to steam collapse, as well as give the incineration point time to adjust to the changing fuel load from the methanol in the SOG.

Any changes in operating rate should be made in small increments (maximum 10%) and as seldom as possible.

For planned shutdowns, condensate and steam flow should be reduced slowly, until 20% of design is reached. At this point stop the condensate flow, but leave the steam flow on.

The SOG should continue to be sent to incineration until the back-pressure control valve goes closed. At this point steam flow to the stripper can be stopped, and the SOG system (which now contains no pollutants), can be shut down.

For an emergency shutdown of an integrated system, condensate flow to the column should be stopped immediately and at the same time the pressure control valve at the column should be closed. However, steam flow should remain unchanged.

This will keep the system in thermal balance, which is especially important if integrated into the evaporator. It will also speed up the restart of the system. As before, on the restart, the condensate flow must be brought on slowly.

CONCLUSION

Environmental regulations require collection and treatment of foul condensates to reduce Kraft Pulp Mill pollution. The stripping of foul condensates is a good in-plant method of accomplishing this. In most cases, the pollutants can be converted to a usable fuel, giving an economic return on investment.

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