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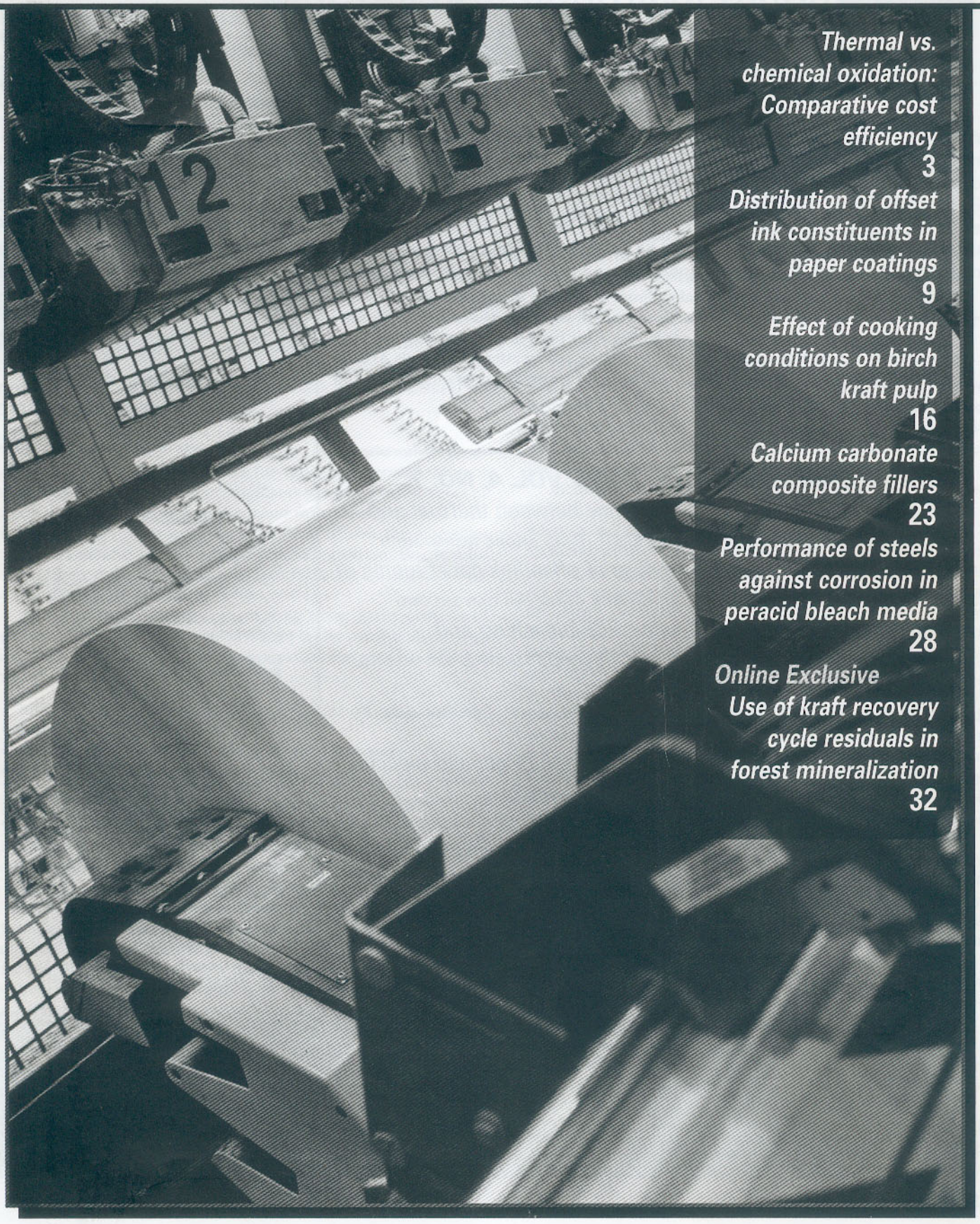

# Comparative annual cost efficiency between thermal and chemical oxidation of TRS in kraft mills

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*An innovative technique for destroying total reduced sulfur (TRS) has been developed and implemented at kraft mills in Canada and the U.S. Statistics are presented on the preferred options for kraft mills for disposing of noncondensable gases. These statistics are geared toward mills in the first phase of MACT I in the U.S. and mills that already comply with the second phase of the Cluster Rule. The annual operating costs of all TRS destruction options are presented in detail to help mill engineers select the best options. Rules of thumb are given to estimate power, steam, water, and chemical costs as functions of HVLC flow and TRS load. In terms of annual operating costs, chemical oxidation is shown to be more cost-efficient when HVLC flow is higher than 10,000 N·m³/h and TRS content is lower than 6.8 kg/h.*

***Application:*** *Engineers can apply these guidelines to estimate and analyze the annual operating costs for destroying TRS by chemical oxidation as opposed to traditional incineration.*

The total reduced sulfur (TRS) in noncondensable gases (NCG) is partly responsible for the characteristic odor of kraft pulping plants. This odor originates mostly from the vents of digesters, blow tanks, and washers and from the equipment used for black liquor recovery. Since the early 1990s, the Canadian provinces and the U.S. have implemented regulations that require kraft pulp manufacturers to collect and treat all major plant vent gases containing TRS [1].

The traditional approach to treating these gases consists of incinerating them, either in a lime kiln, in the plant boilers, or in a dedicated incinerator. However, thermal incineration of NCG has several drawbacks:

- Risk of toxic gas inhalation (leakage points on aging boilers)
- Risk of explosion
- Reluctance of personnel to operate the equipment
- Complexity of safety devices
- High operating costs
- High costs of boiler modifications.

Additional information about traditional incinerating methods and technologies can be found elsewhere [2–5].

To help mills avoid the constraints and high capital and operating costs, certain equipment manufacturers that specialize in the treatment of industrial emissions have developed alternative approaches. These approaches consist of chemically oxidizing the contaminants in the NCG using powerful oxidizers such as sodium hypochlorite or chlorine dioxide. These chemicals are used for pulp bleaching and thus readily available at any plant that has a bleaching process.

Here, we will first look at annual operating costs for the major options in treating high-volume, low-concentration (HVLC) gases. Then we will look at those situations in which either approach, chemical or thermal oxidation, is more cost efficient, specifically for the plant with a bleaching process.

## NCG TREATMENT OPTIONS

### Thermal oxidation options

The incineration of HVLC is the traditional approach used in destroying TRS contaminants. Alternative techniques for incinerating NCG include lime kilns, recovery or power boilers, and dedicated incinerators like direct or regenerative and flare incinerators.

Incineration in a mill's existing facilities is the most popular option, since it does not require any major capital investment or mill modification. The lime kiln is limited for HVLC incineration because the volume to be treated is often too large and may affect burner operation. However, power boilers and recovery boilers are well suited to using HVLC as secondary combustion air or tertiary air for recovery. For these approaches, foul gases must be conditioned prior to being incinerated to avoid hazards associated with turpentine and to minimize corrosion and water condensation.

When constraints force the mill to operate with dedicated incineration devices, thermal oxidizing is the preferred option. It is also the cheapest, and it may be combined with a waste heat boiler to produce steam and compensate for the large amount of fuel required. Thermal oxidizers may also be operated when the mill has an available source of waste fuel like stripper off gas, such as methanol or turpentine.

An alternative to a thermal oxidizer is a regenerative thermal oxidizer, which is the highest capital cost option for HVLC incineration. However, its fuel consumption is only 15–25% of the thermal oxidizer cost, which is the determinant when the incinerator is the primary NCG incineration device.

Finally, some mills use a flare to burn NCG, but a flare is restricted to low-volume, high-concentration (LVHC) incineration and is used as backup only.

### Chemical oxidation options

Over the last six years, tremendous efforts have been made to develop alternatives to thermal incineration of air contaminants from kraft mills.

The earliest approach to NCG treatment using a chemical oxidizer was to use a conventional packed tower scrubber.