Deriving profit from pollutants

In pursuit of pentoses

Daily, thousands of tonnes of a foul-smelling, dark brown liquid are poured into fresh waters by Canadian pulp and paper mills. This odorous brew, called spent sulphite liquor (SSL), is a by-product of the pulping process, generated at a rate of 4.8 t for every tonne of pulp produced. It is disposed of because there is as yet no cost-efficient technique to exploit the potential value of this unwanted effluent.

Thanks to research done recently at NRC's Division of Biological Sciences, the problem may soon be alleviated. A group headed by biochemist Dr. Henry Schneider has found a way to convert certain of the organic wastes in the liquors into a valuable product; as well, his discovery could have wide application in the disposal of numerous other biomass wastes, particularly agricultural and forestry residues. Schneider's research involves the growth conditions of yeasts and their ability to ferment sugars into alcohol. What he has done, in effect, is broaden their diet, previously restricted to so-called six-carbon sugars (like glucose), to include five-carbon sugars (like xylose) that are not normally touched by yeasts.

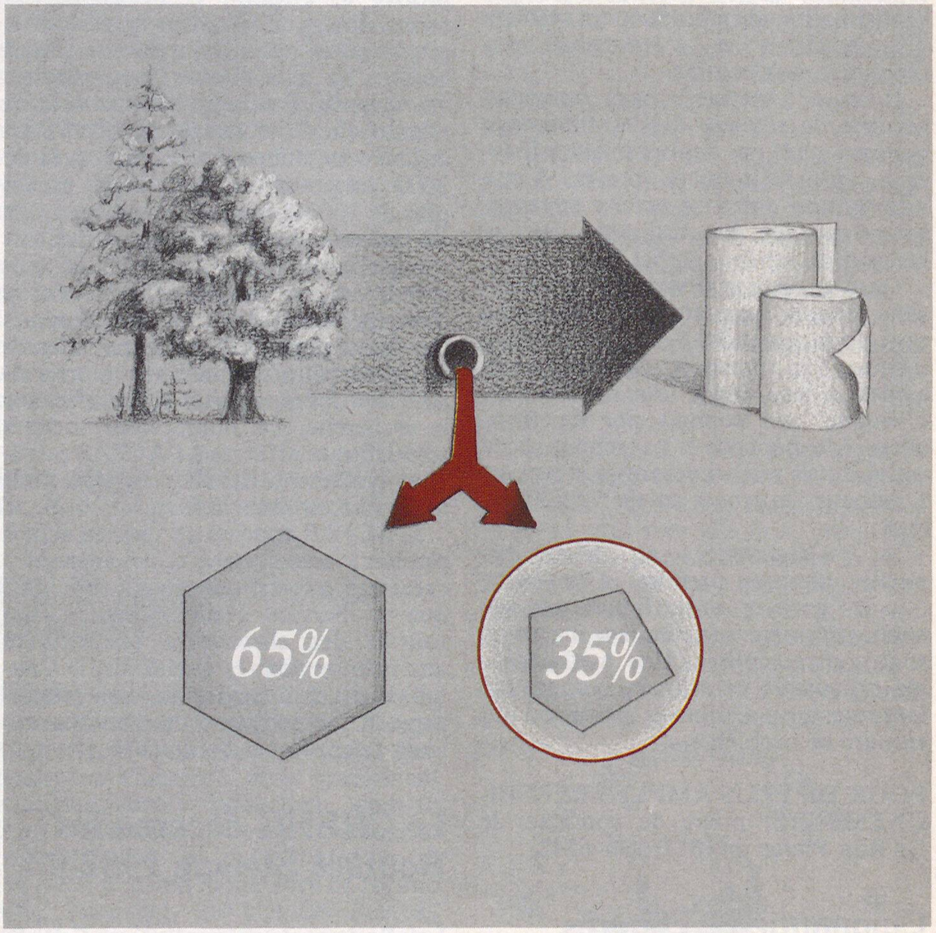
Since the 1880's, it has been known that yeasts are capable of converting some of the sugars present in pulping liquors to ethanol. Ethanol in turn can be used to produce, among other things, potable spirits, thinners, solvents, and varnishes, and recently ethanol has been suggested as a possible gasoline extender. In Europe and North America, facilities that process pulping effluent to produce ethanol have been built to carry out the fermentation of sugars to alcohol, but only under anaerobic (oxygen-free) conditions and only the hexoses, or six-carbon sugars, can be fermented. Unfortunately, the pentoses, or five-carbon sugars such as the above-mentioned xylose, are ignored by the yeasts and pass through the system unaltered; in the case of pulping effluent this is a hefty loss, averaging 35 per cent of the total sugars present. With Schneider's discovery, the economic returns from the use of pulping effluent in the production of a valuable product have improved.

"The problem with biomass conversion has always been that yeasts ferment hexoses but not pentoses," explains Schneider. "With the increase in ethanol production due to pentose fermentation and with the increasing value of ethanol, especially as a gasoline extender, in certain cases it becomes not only feasible financially but actually quite lucrative to set up treatment facilities for pulping effluent." Apparently industry agrees with him. Since his first paper on the subject was published in February 1981, Canadian industry has practically been camping on his doorstep. The NRC scientist now has a thick file of enquiries from around the world.

Dr. Schneider had been accumulating a solid data base on yeast fermentation for almost three years when a Japanese paper, in February 1980, indicated a new direction. At the time, existing practice employed anaerobic conditions, which resulted in the fermentation of only the hexoses. The Japanese, however, discovered that a certain yeast could produce much more alcohol under aerobic than anaerobic conditions from hexoses. Intrigued by this, Schneider and his team immediately began to test many yeasts under varying aerobic conditions, looking for a yeast that could ferment the biomass pentose. "By December 1980, we had isolated our quarry, *Pachysolen tannophilus*," enthuses Dr. Schneider, "a yeast that ferments xylose with a vengeance."

Having found *P. tannophilus*, Schneider's next step is to finely tune the growth conditions of the yeast to attain a fermentation efficiency as close as possible to theoretical maximum. At what temperature, at what oxygen level, and under what other conditions will *P. tannophilus* ferment all available xylose as rapidly as possible? The answers to these questions provide the directions for further research.

The NRC research team is also broadening the scope of its work to in-



In the process of turning trees into paper, an effluent is produced that has a high sugar content. Of this sugar, 65 per cent is hexoses and 35 per cent is pentoses. Dr. Schneider has made it possible for the yeast to ferment all of this sugar rather than just the hexoses.

La fabrication de la pâte à papier s'accompagne de la production de liqueurs résiduaires très riches en sucres. Or, le Dr Schneider a obtenu une levure capable de fermenter non seulement les hexoses mais également les pentoses qui les composent et dont les proportions sont respectivement de 65 et 35%.