Pulp and paper pollutant
Seen as rubber reinforcer

In paper-making, logs are debarked, chipped and digested with aqueous solutions of caustic soda and several sodium-sulphur compounds. As the pulp is recovered for further processing, a dark solution remains. This solution has long constituted a serious disposal problem and, if left untreated, contributes to the pollution of waterways. Industries have tried hard to find profitable uses for it with varying success.

When this waste solution is boiled, there results a syrupy black liquor containing high concentrations of dissolved lignin. Lignin constitutes up to 30 percent of wood content and is the major non-carbohydrate component in all wood. It is the "cement" which binds the cellulose strands in the basic wood fiber — the more lignin, the harder the wood.

Lignin is a complex substance, a polymer, that is, a large molecule made up of a basic unit repeated many times over. (Despite its ubiquity, scientists are still not sure of its composition). Twenty or so of its basic units (the "monomer") join to give linear chains which are then cross-linked into a molecular network extending throughout the wood. It has been said that all the lignin in a softwood tree is just one big polymeric molecule!

About two million tons of lignin are marketed annually by Canadian industry in the manufacture of newsprint and kraft board. Further quantities of lignin are transformed into vanillin, the source of vanilla flavoring; oxalic acid can also be obtained from this substance. But in view of the enormous supply of lignin, new commercial uses for it are welcomed by Canadian industry.

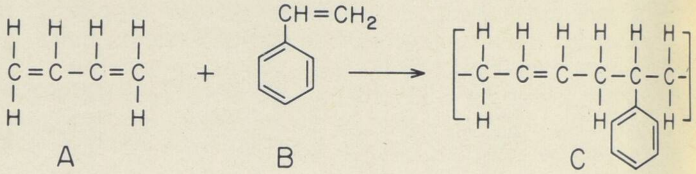
Much time and effort have gone into turning the enormous quantities of lignin encountered by the pulp and paper industry into an asset instead of a liability. The National Research Council of Canada has recently given significant thrust to this by finding what promises to be an economical use for lignin in an industry somewhat removed from pulp and paper — the rubber industry. NRC is now interested in having industry's participation and cooperation in order to realize the full potential of the NRC result.

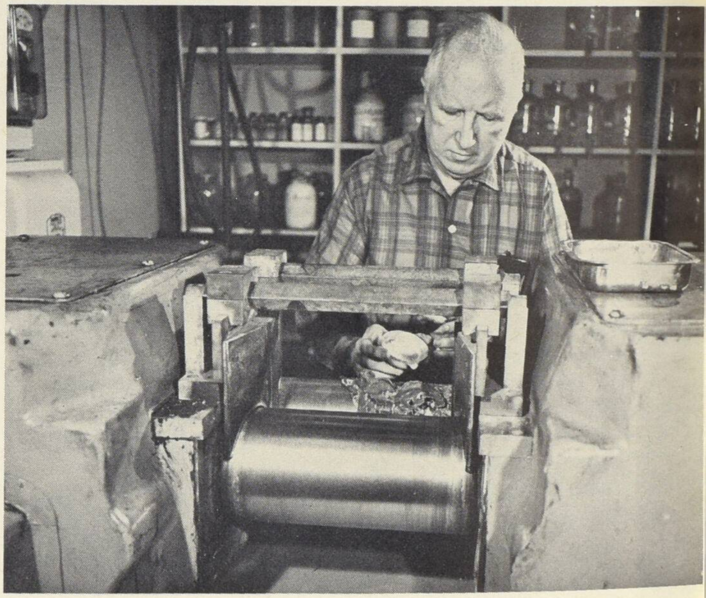
Dr. I.E. Puddington, Director of NRC's Division of Chemistry and Head of its Colloid Section, and co-worker Dr. A.F. Sirianni have turned dry lignin into a reinforcing agent for styrene-butadiene rubber (SBR) of such quality and ease of application that in certain fields it could rival carbon black, the main SBR rubber reinforcer. It seems that lignin can give tensile strength and resistance to abrasion which under certain circumstances outshines even its carbon-black counterparts.

However, lignin rubbers will not reach their full potential without the collaboration of the Canadian pulp and paper and rubber industries. Only a joint effort with important input from Canadian industry can turn this potential pollutant into an important component of a marketable rubber product.

NRC's interest in lignin rubbers dates back to the late 1940s when it was established that lignin, precipitated together with rubber latex, could be formed into a useful

Lignin is a useful reinforcing agent for SBR rubber. This synthetic rubber is made from butadiene (A) and styrene (B) which react to form a polymer with elastic properties. The polymer is composed of a basic unit (C) repeated many times over. ● La lignine sert à renforcer le caoutchouc synthétique dit "SBR", produit à partir de butadiène (A) et de styrène (B). Ces deux substances forment un polymère élastique composé d'une unité de base (C) répétée maintes fois.





Introduction of dry lignin into rubber mechanically, by milling. Above, Clarence Barker adds silane to crude rubber at start of milling to promote lignin-rubber bonding. Below, left to right, dry lignin ready for milling, the product after 10 minutes of milling and the vulcanized product after curing. ● Introduction de la lignine sèche dans le caoutchouc mécaniquement par broyage. En haut, Clarence Barker ajoute du silane au caoutchouc brut afin de favoriser la liaison de celui-ci avec la lignine. En bas, de gauche à droite, la lignine sèche prête à être introduite dans le caoutchouc, le produit après 10 minutes de broyage et le produit final après vulcanisation.