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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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STUDY ON SYNTHETIC VERSUS NATURAL PRODUCTS
PILOT PROJECT ON THE RUBBER INDUSTRY
AND ITS IMPACT ON THE ENVIRONMENT 1/

by

Anton J. Wagner*

* UNIDO Consultant.

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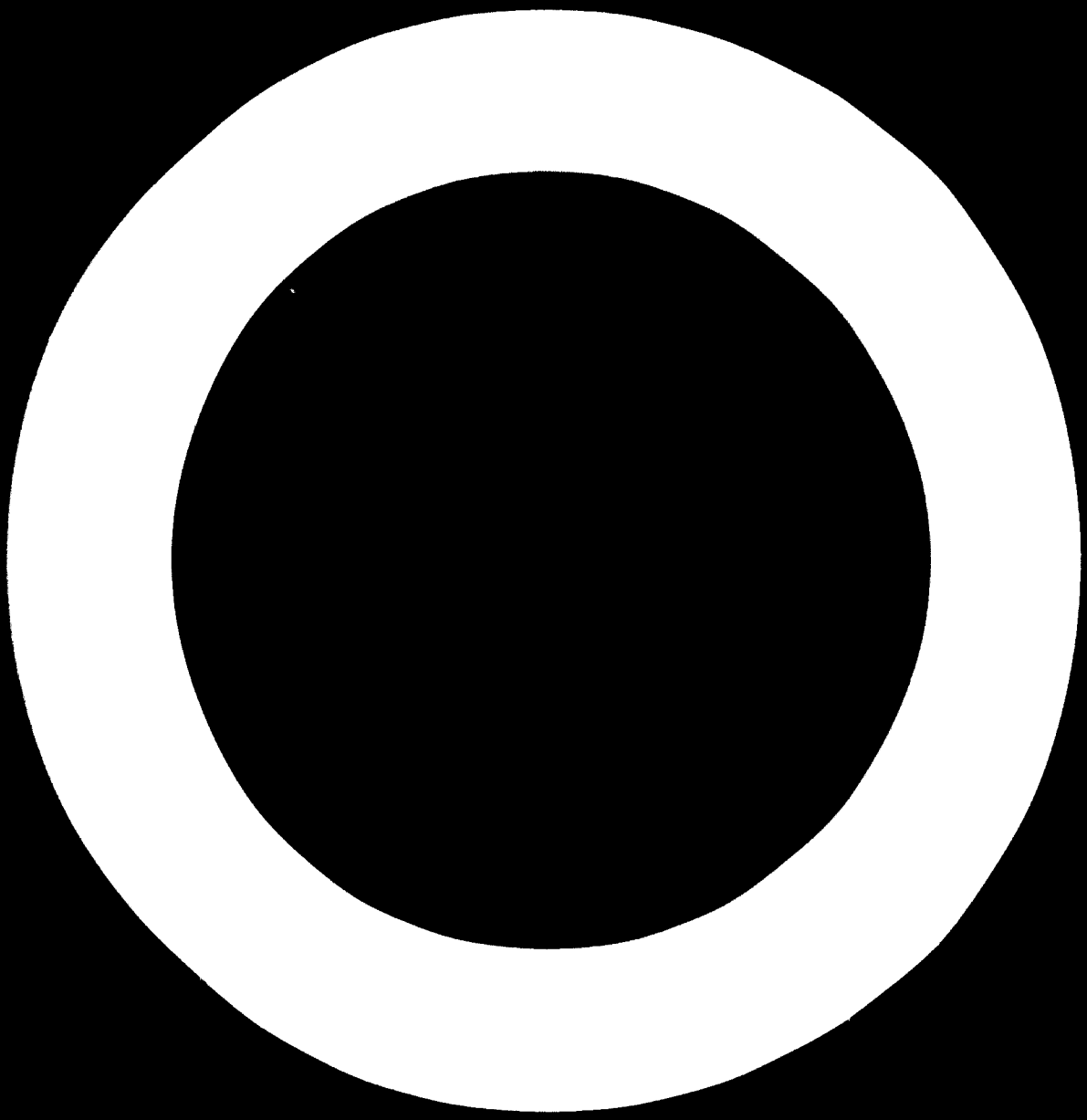

A STUDY

ON THE ECONOMIC ASPECTS OF THE TYRE INDUSTRY

AND ITS IMPACT ON ENVIRONMENT, including the following:

a) Brief description of the technological process used in the manufacture of tires and technical articles with reference to the various sources of pollution. Investment costs for pollution control and prevention.

b) Influence of pollution control and prevention on production costs, profitability and selling prices in the above mentioned fields.

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The rubber goods industry's environmental objectives:

It is a matter of fact that social and economic objectives are always better known than environmental objectives. A relatively new phenomenon is the fact that business leaders take over responsibilities to society in developed and developing countries. Not only the production of goods and services connected with profits, but also insistent pressures for greater traffic safety, a cleaner environment, and improved education on the job are subjects to be considered and assessed in to-days' enterprises. To get these tasks done the government plays an expanded role in our economic life and many regulations and laws are being suggested or already effective.

The environmental objectives, therefore, are to assure that our operations and products do not create a significant hazard to public health and are compatible with the environmental, social and economic aspirations and needs of the community. It is a necessity to work in co-operation with outside groups toward a consensus on environmental quality standards which are desirable and attainable and adhere to all environmental standards and regulations which may be applicable to our business.

INTRODUCTION:

This study was carried out over a short period of time and it was not possible to make reliable measurements on air and water pollution caused by a tire plant. All the papers which have been studied did not show any definitive value in this regard. But many experiences are at hand and can be taken as guideline at first to assess the costs which are involved to protect people working in the tire plant and people and vegetation in the neighbourhood of the factory. Hence to make a binding statement it is still a matter of probability which nevertheless needs to be proven by the practical achievements in this regard. For this reason and due to the fact that empirical figures are available and confirmed, this study can provide estimates which seem to be realistic and they may be serving the purpose to make recommendations for setting up new tire plants in developing countries.

The oil crisis, the worldwide inflation, the trends of prices in the world markets, the increase of production costs almost everywhere, the tendency to find new energy resources and different political and economic aspects in various countries make it understandable that the following study can only produce considerations and figures in comparison with relation to existing data in this line. As the conditions differ very considerably from country to country it would be preferable to make separate feasibility studies based on local facts. Even geographical and atmospheric features can play a certain role in environmental effects which have to be assessed differently from place to place.

Scientific measurements and results on air and water pollution can only be achieved when adequate tests could be performed on the spot over an extended period of time.

R E S U M E

of the following study.

The economic aspects of the tire industry which accounts for about 60% of the total rubber goods industry have been relatively good for the years from 1964 to 1972. During this time a continuous upward trend with regard to the consumption and to the output of the tire industry at steadily rising prices was predominant. The prices grew quicker than the wage increases took place and the raw material prices were with slight ups and downs constant. Since 1973 the oil crisis and its consequences with higher raw material prices and reduced tire consumption, the inflation almost everywhere and the increase of labour and production costs have created a completely new situation. This development led to a very competitive marketing problem which caused declining prices for the finished products. Selling prices in this study are indicating the present European price levels for passenger car tires.

To sum up the pollution problem of a tire plant where exhausters and filters are adequately installed and frequently cleaned, almost no environmental effects are noticed so far. The plant itself and its adjacent neighbourhood are practically free of any air or water pollution. The practical effect, because no scientific measurements are made, is proven through the fact that no health hazards are reported and the flower garden and trees in the courtyards of the plant and around the factory grow quite well and show no adverse effect. It is also said that the fume leaving the tall chimney of the plant does not contain any poisonous pollutants. The water emission of the plant is filtered and cleaned and causes no pollution at all. The total operation of the tire plant to eliminate all pollutants in the manufacturing process accounts for 0.4% of the average value of a passenger tire within a production period of ten years. By this equivalent the investment cost for new protection equipment against air and water pollution is paid off. The solid waste of a tire plant has been indicated but it was not subject to this study.

Finally it can be said that a modern tire plant with the right installation of prevention equipment against air and water pollution does not practically pollute the environment. All precautions are taken to ensure the safety of the workers on their working shops, and special safety engineers are in charge of this task.

The socio-economic aspects for the people employed in a rubber tire plant can be considered as good and also the community where such a plant is located can take advantages in many regards. Being able to set up additional exports to other countries would be a further considerable advantage for the trade balance and the GNP of the exporting country.

The new trend in setting up tire plants leads to large consuming areas and to developing countries where adequate market is available. In developing countries where the consumption of tires is not sufficient for making new tires, it is advisable to start-off with a retreading tire industry and later on step by step when sufficient demand is coming up for larger quantities of tires to set up a tire plant. But in every case of setting up new operations, it is recommended to have the know-how of an already existing industry and also the control of an operation for an extended period of time. The durable market potential, the continuous trend in development and innovations should be considered very carefully at any time and anywhere.

Brief description of the [illegible] processes used in the manufacture of tires with reference to the various sources of pollution.

The real work of processing can begin as soon as the raw materials are warehoused, checked and the uniformity and acceptability are proved. Natural rubber, synthetic rubber, fillers, softeners and sulphur according to recipes of the element are conveyed to the compounding room. The recipes for truck tires are based mostly on natural rubber (smoked sheets) and for passenger car tires more on synthetic rubber with the exception for winter tires in which natural rubber is also used. In the compounding room the chemicals are exactly weighed and forwarded automatically to the mixing equipment where internal mixers, like Banbury mixers or others, are used. A special conveying equipment is necessary for carbon blacks. It is completely tight and leads from the special delivery tankers directly to the plant, over storaging, weighing and supplying to the internal mixers where the primary mixing of the total compound is made. The internal mixer gives greater volume of good uniform production per man-hour, less dirt and much safer working conditions than does the open mill which may be used in smaller operations. There are many variations in the charging of an internal mixer and as many in the length of the mixing cycle. But the modern trend is to put it all in, mix it, and dump the batch directly onto a mill, or down onto a conveyer or into a large volume extruding machine. Through the milling and extruding the stock is forced into a thick, continuous length sheet or strip which is going directly to the extruders for building the tread rubber and sidewall rubber and to the calender for coating the tire cord on both sides, or the stock is cut into slabs and stored until needed.

- When the conveying of carbon black is in the right way and no carbon dust can escape, the next pollution area in the tire plant is the mixing room. A continuous system must be available and dirt and dust have to be eliminated by exhausters and filter equipment for carbon blacks. To warrant an effective operation of the filters it is necessary that the filters must be cleaned every two weeks at least. -

The carcass or body of a tire consists of rubber compound impregnated plies of Rayon or Nylon or steel tire cord which is made to very strict specifications. The textile fiber cord must be dipped in a solution, impregnated with latex and dried before being coated with rubber compound. The dipping operation can be done in the plant or the tire cord is already dipped when bought. The dipped cord in stock must be kept fresh in the latter case.

- The dipping operation also causes an air pollution by a slight evaporation of the solution which must be kept strictly under control and must be eliminated by exhausters. -

From there the cord is led to the calender (either a three-roll or four-roll type) where it is coated on both sides, thoroughly and evenly, with the rubber compound.

- To keep the air clean in the room where the calender is installed it is recommended as well to have exhausters and air conditioning equipment available. -

A continuous strip of rubber compounds is led to the extruder where the shaped treads, sidewalls, inner tubes and strips of different sizes and shapes are made.

A tire has to be held firmly to the steel rim on which it is used and this is accomplished by an extremely high tensile wire bead. The wire bead will be purchased and is processed with special equipment. Finally the bead is wrapped in with rubber compound coated fabric cut to width at an angle and which helps to maintain the bead in shape while uncured and to reinforce the bead area of the tire when cured.

In the tire preparation department the roll of calendered tire cord is automatically cut to the proper width and angle for use in a particular size and type of tire. After cutting, the stock is rolled up in liners and brought to the tire building equipment.

There are two general types of tire building equipment, one for single bead tires and another for multiple bead tires. Tires for automobiles [illegible] beads, as do the smaller truck tires. The larger truck tires (20" and more) and special purpose tires generally have two or more beads.

The tire building equipment consists of tire build-drums on which the tires are to be formed and a revolving turret by which the tire fabric is delivered to each drum. The prepared plies and the beads are applied to the building drum and on top of the so-built carcass the tread and sidewall rubber are pressed firmly to the carcass. The drum is now collapsed so that the tire may be removed. The "green" tire is now taken to a tread-splice presser and from there brought to the curing department.

- In the building department no remarkable pollution is produced and a regular cleaning service keeps the place clean. -

Some modern vulcanization presses do the forming, inserting the curing bag, centering in the tire mold, curing and removing from the mold automatically. All of the factors having to do with the curing of the tire are controlled automatically and a timing mechanism ensures correct curing cycles. When the cure is complete the press opens automatically and the tire is ejected from the mold. After curing the tire is delivered to the final finish department.

- The fume and steam released after the curing process is taken off by exhausters which try to keep the air clean and an air conditioning system keeps the temperature in the curing department bearable. -

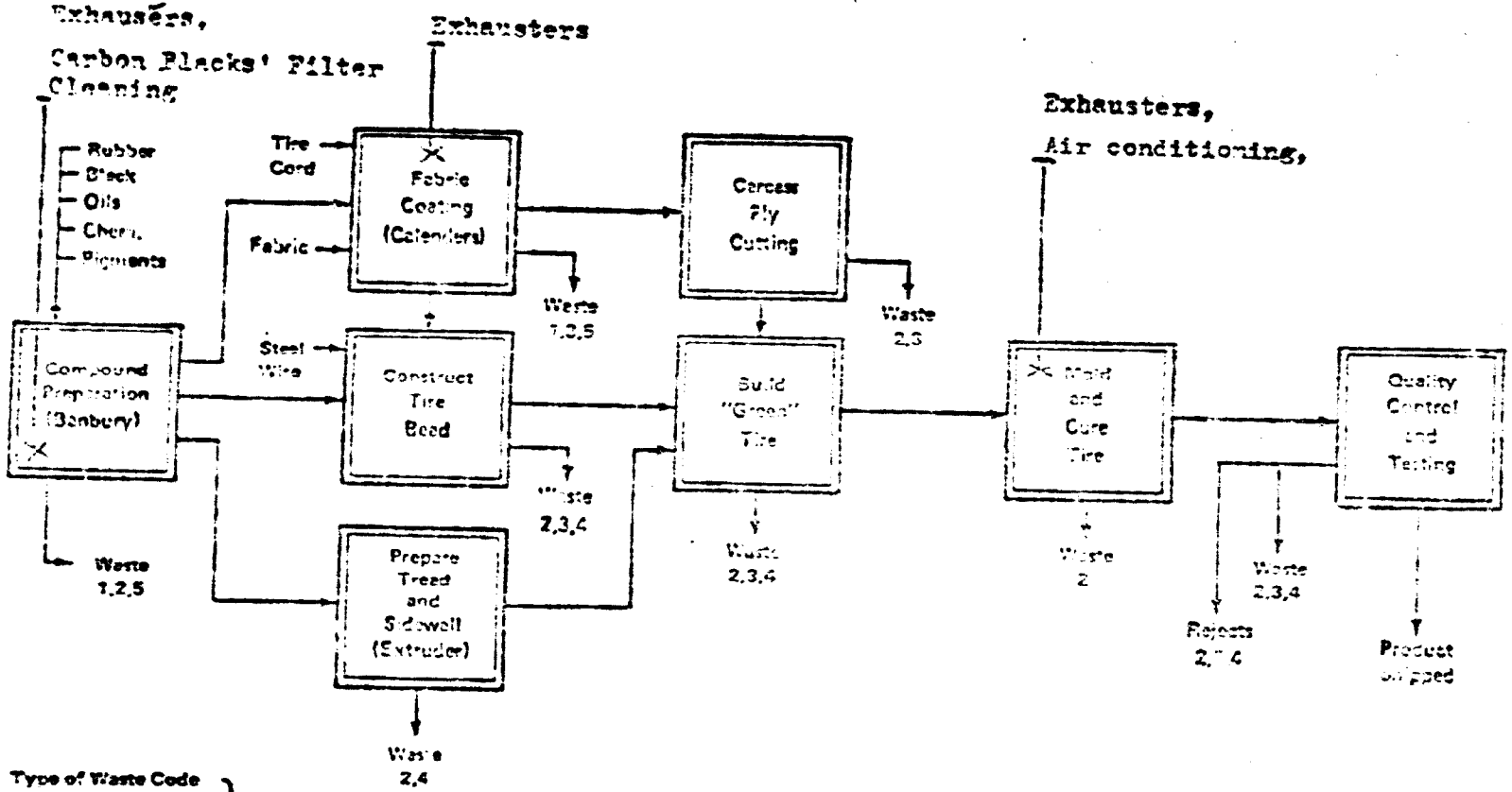
After passing the final inspection the tire is brought to the finished goods warehouse for storage until being sold.

Now-a-days there are two widely different tire constructions, the current bias angle tire as described before and the radial tire which is the more and more coming tire. In USA there is still another type, the belted bias tire, which is a conventional carcass with a reinforcing belt under the tread rubber of the tire. The radial tire consists of only two plies in fabric or one ply in steel cord in general. The plies are applied on a tire building drum and the beads on both sides of the drum are attached to the carcass. However, in this case the cords in the ply or plies are not put diagonally but straight across the tire from bead to bead, almost radial. The next operation in building the radial tire is to remove the carcass from the drum, insert an air bag or another equipment and extend the carcass into a toroidal shape of a tire. At this point three or four plies or belts are added into the crown area of the tire. On the top the tread rubber is applied - the sidewall rubber has already been applied on the tire building drum and then the assembly of a tire is finished and the green tire is brought to the curing department. The curing department is in principle the same as it is for the bias tires. Only the molds of the curing equipment have to be divided in some sections in order to give room when ejected.

The radial tire has a somewhat harder ride than the bias tire but gives better mileage, good stability, excellent traction and greater safety. The radial tire developed by Michelin in France in the early forties has experienced increasing use on the European continent for about 30 years. Also in USA the radial tire is gaining more and more the market and covers about 10 to 20% of it whereas e.g. in France the coverage amounts to more than 80% of the tire market.

Tire technology is trying continuously to bring along safer tires and new constructions (see Trends in Tyre Technology and Safety Standards and Implications for Rubber published by the International Rubber Study Group, London) and will continue to do so.

POLLUTION AREAS IN THE TIRE PLANT:



Type of Waste Code
1—Paper, Cardboard
2—Rubber Compound
3—Textile Materials
4—Metal
5—Other

Solid waste amounts to about 7% of the tire weight manufactured.

The water effluence of the tire plant is filtered and cleaned completely.

Another pollution spot in a tire plant is the solid waste which occurs every working day. This waste consists of paper, cardboard, rubber compound, textile materials, metal and others which amounts to about 7% of the tire weight manufactured. Many truck loads are required every day to haul the waste to land fills or burning plants which are at hand.
The water effluence of a tire plant is filtered and cleaned completely.
To sum up the total pollution problem of a tire plant, it can be said, as the practice shows, that almost no air and water pollution is caused by such a plant which can be proved in many cases.

Until now there is a considerable waste problem by used and worn out tires which has to be solved almost everywhere. For this purpose many recycling processes are examined and studied for the time being but no final solution has been found so far.

The manufacture of other rubber goods:
It has been proven all over the world that a tire factory should be ready to expand its production into other rubber goods such as camelback which is used for retreading operations, inner tubes and conveyor and V-belts. Other additional rubber plants could be established for the manufacture of hoses, sealings and gaskets, rubber footwear which are only few in number to support a factory by themselves. The processing line for other rubber items is more or less the same, viz. at first the mixing of the compound which must be adjusted in its properties to the end use of the product, then the building or forming and finally the curing process. The equipment of the manufacturing line differs according to the product made but the mixing of the compound can be performed in the raw material mixing room of one plant. If the market is available for other products too and the economic feasibility given then it is worthwhile to manufacture other rubber goods too besides tires. The enlargement of the

manufacturing processes is not only an advantage for the enterprise itself but also for the whole economy in which the standard of living does improve readily.

An existing new tire factory has very often in the one or the other manufacturing department some capacity free which can be used easily for additional manufacturing lines and in this case a better profitability could be achieved right from the start of the plant.

The manufacture of inner tubes:

Inner tubes are extruded as tubes by the use of special head which allows the use of air under die to produce a hollow cylinder of a special butyl rubber compound. It is then cut to the final splicing length and the scrap sent back to the tube for mixing with fresh stock. The valve is applied and the tube is cut to length and spliced. It is then dusted with talc and inflated around an inflating ring of the correct size. The tube mold is fixed to a clamshell press similar to the manner of the tire mold. The press has an automatic timing system and other controls for automatic action. With the press open the partially inflated tube is centered in the bottom half of the mold, valve inserted through the hole in the mold and the press closed. Immediately upon the press being closed, compressed air is ejected into the tube causing it to be pressed strongly against every portion of the inside of the curing mold. The pressure is continued until curing is complete when the tube is exhausted of air and the press automatically opens. The operator removes the cured tube by hand and places it aside to cool. The vulcanization takes only a few minutes.

- The dust which is produced by talcing and the curing area where steam and heat are produced must be protected by strong exhausters and filters to clean up the air accordingly. -

The tube will be checked and inspected for leaks after inflation under water and finally folded and packed into a carton.

It would lead too far in this study to describe all the other manufacturing lines of rubber products including the manufacture of hard rubber items too. The mixing compound for hard rubber or ebonite consists of more than 50% sulphur and the processing is also different compared to soft rubber compounds.

Investment costs for pollution control and prevention:

In the previous chapters describing the manufacture of tires the pollution areas of a tire plant have been indicated and also the equipment which is needed to prevent the pollution effects. In order to come to reliable cost relations with respect to pollution control it would be best to consider at first the costs involved for environmental protection when planning and setting up a new tire plant. Already existing plants could distort the calculation by the fact that the building itself does not fit to an additional equipment which is necessary for pollution control. Setting up a new plant where the room is adequate for installing the complete equipment in the ordered way, this would show reliable estimates and the best protection against pollution hazards. As the depreciation in various countries for capital investment varies from five to ten years it would be advisable to set the costs for the total pollution equipment in such a relation which gives to the tire manufactured a percentage which has to be added to the tire cost value. In this percentage must be included the maintenance of the equipment too. There is another main factor which affects the percentage considerably and this is the capacity of the plant. To get a reliable average of the size of a plant many existing tire plants have been checked in this regard and it seems that an average capacity of a tire plant would be about 4000 passenger car tires a day. The manufacturing equipment for the conventional bias angle tires is less expensive than the equipment for the manufacture of radial tires, but radial belted tires are gaining esteem and more and more entry into the world market; it is a matter of reason to bring the estimate into this relation too.

The costs for land and building of a tire plant are also excluded because they differ considerably from one country to another. All that is taken into calculation consisting of the manufacturing

equipment for the manufacture of about [illegible] passenger car pneumatic tires a day, including power, [illegible] water supply, carbon black conveyor, [illegible] equipment and a small per cent for [illegible] contingencies. When at the same time other rubber items should [illegible] the capacity or allround production [illegible] would be the acceptable middle size of [illegible] is taken under consideration.

The environmental protection [illegible] described in the previous part of this study should not exceed an estimated amount of US$ 1,150,000.- for such a plant. This amount would cover the filtering and cooling system of the plant and the air conditioning where especially [illegible]. The worst parts of the plant are of course the curing department and the area where the mixing and milling is done.

These costs compared to the investment for a new plant equipment would amount to 2,3% of it approximately. If you are going to put the costs of the environmental protection in a ratio to the manufacture of about 7000 radial tires a day and you have 250 annual working days of one year and consider a period of ten years then the cost for environmental protection within the plant of every tire manufactured in this 10 year period would amount to about 0.4%, or in the first year period to about 0.2%. The manufacturing cost of a tire can alter widely due to considerable differences in wages from country to country and due to different raw material costs which are also depending on the location where the plant will be set up. Different freight rates and handling charges are involved and also different currency exchange rates. The maintenance of the equipment and the cost for the cleaning of the filter should be covered by the production costs. In general the wage factor of a tire manufactured amounts to 20 to 40% but still there are countries where it is only 10%. On the contrary the raw material costs alter from country to country as well.

Influence of pollution control and prevention on production costs, profitability and earnings position in the tire manufacturing field.

There are many tire manufacturers in USA, Europe, Japan and other countries all over the world but the leading among them are only few which have shown in their business reports of the past years a net income of 2 to 5% up to 1973, a ratio of net income to net sales demonstrating the profitability of the industry. The continuous upward trend in profitability since 1964 was given due to the fact that the world demand was continuously growing in these years and many companies set up wholly owned retail outlet to increase their profits. The commercial development in many areas led to nationalizations of the production program and to specialization or diversification as the economic circumstances demanded and required it. In Europe many manufacturers were looking to new co-operations with companies abroad to enlarge the volume and output of their plants and to find a better marketing service for their customers. At the same time a better specialization and specification in quality products was achievable and at rooms in many cases. The passenger car, the truck and the special service tire market is divided into two main categories. The one market of original equipment tires for vehicle manufacturers and the other one for the trade as replacement tire market. The markets in USA, Europe and Japan are very competitive and even continuously rising; tire prices for the time being do not mean that the profitability is improving at present. The costs of raw materials, the cost of labour, of transportation and other factors involved have caused a continuous rising of the production cost in recent times which cannot be covered by rising prices of tires until now. Therefore, many companies, only with the exception of few, were in red figures for the last two years. The new safety regulations, the pollution control and the cost for waste removal have also affected the profitability in most developed countries. As the tire manufacturers do not have any more the possibility to suggest retail prices for the trade as it is a necessity to sell at net prices and the retailer has to make the prices for the customer while adding

his overhead and profit margin. [illegible] of the tire manufacturers in Europe range up to approximately DM 20.- to 20.- for regular bias tires and from DM 30.- to 50.- for radial tires in the sizes 13" to 15". If the manufacturing program includes truck tires which have still an additional demand in the market the profitability of a tire plant can be improved at present. The passenger car traffic has considerably diminished during the oil crisis effects and therefore the demand in the tire replacement and OE market has also been reduced.

The domestic retail prices from country to country differ a little bit depending on whether a local manufacturer is available or the demand must be covered by imports alone. In the latter case the currency relations, the customs duties and export incentives have to be evaluated and as well as the taxes.

Tire Retreading:

Before ending up this study I would like to draw the attention of developing countries again to the fact of re-using waste materials. But also developed countries where an ecological effect is mostly required, the retreading of a tire is becoming more and more wanted. The conventional and also the radial tires are retreadable and the latter having a stronger belt under the tread of a tire give a considerably longer life span. The retreaded tire costs about 50% of a new tire and gives an additional lifespan of about 80% of a new tire. But there is a necessity which cannot be overlooked and which is very important that the retreading and recapping of a tire have to be done in the right way with modern equipment. The workers must be well trained and on modern equipment they must be able to produce correct retreads. Otherwise the retreading becomes suspect and many people could be afraid of it. Quality camelback for retreading can be delivered from almost every rubber goods factory where extruding can be done.

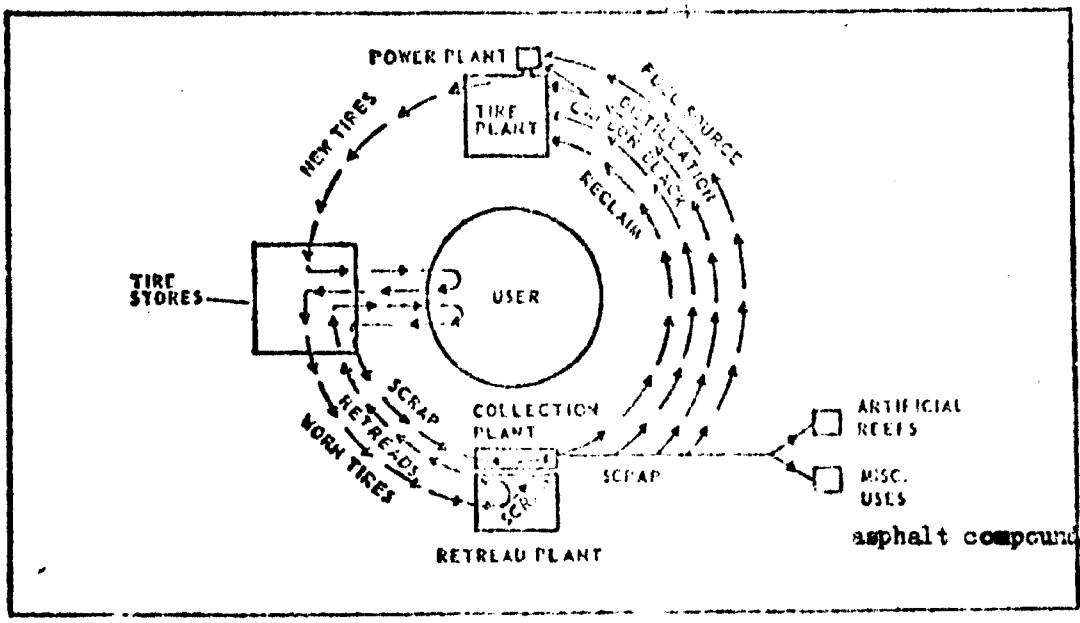
There is cured and uncured carcass on the market and according to the size etc and the pitching of the tyre also the material can be chosen. Even in the most affluent country, the USA, the annual amount of scrapping of tires is steadily growing and especially in the last two years more than previously. The speed limits on highways and the rising tire prices are fostering this trend.

The tire recycling is not exhausted by retreading. The totally worn out tires can be used in artificial mats or reclaim rubber can be produced out of them or new energy sources by burning the worn out tires can be achieved. There is also a method in research to use tire scrap in road covering compounds which could lead to a final decision. The price factor and the amount of components for covering the roads compared with the availability of the material seems to be unclear for the time being. But it is expected that further details will be available pretty soon.

While setting up a new plant for manufacturing reclaim rubber, the economic demand must be given. As long as natural rubber and SBR are available at competitive prices, the need for a reclaim rubber plant will not be very attractive.

A similar situation is given when a tire manufacturing industry is studying the need of a burning plant in order to produce new additional energy. If energy is available in abundance in some areas and at reasonable prices then an additional burning plant will not find an economic solution. The estimated investment costs for such a plant corresponding to the size of a tire plant as outlined will account to DM 2 to $4 m. as per execution and location. But there is no doubt that the community and the state should be predominently interested in cleaning up the public waste areas where used tires are thrown away and in establishing burning plants. In this case also the solid waste of a tire plant could be usefully destroyed.

TIRE RECYCLING:



But it is worth noting that the incineration of tires is one of the most [illegible] technologies currently being pursued in the world [illegible] in the form of real new products there are many conflicting information and publicity. The incineration must achieve a complete combustion, the air pollution control must be perfect and the metal removal must be easily performed. The [illegible] with the International Air Pollution [illegible] and therefore the gas cleaning equipment is important. Discharge of fine particles is an unacceptable pollutant.

If the rubber industry would have to take over the charges for collecting the worn out tires at the end user and to burn them in a new burning plant it would be necessary to make separate evaluations for this purpose. A rough estimate would also amount to maximum [illegible]% of the manufacturing cost of a tire within a ten year manufacturing period. Under the present economic situation of the rubber industry it would be reasonable when publicly preferred funds would be granted for setting up an additional burning plant to an existing tire industry.

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