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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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PRESENT SITUATION IN THE DEVELOPMENT OF HIGH-PRESSURE POLYETHYLENE PRODUCTION[1]

by

K.H. Imhausen
Imhausen International
Company mbH
Lahr
Federal Republic of Germany

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PROJECT SELECTION IN THE DEVELOPMENT OF HIGH-PRESSURE POLYETHYLENE PRODUCTION

by
K-H. [illegible]
Imhausen International Co.
[illegible]

The extremely rapid development of polyethylene production, particularly of high-pressure polyethylene, in all industrialised countries of the world has continued unabated during the past 30 years. Thus world output of high-pressure polyethylene increased by 77,5% between 1965 and 1966. The total annual capacity now exceeds 5 million tons.

On one hand the demand for the inexpensive intermediate product polyethylene with its wide field of application has continually increased while on the other hand ever larger or eking installations and gas decomposition units have made the production available.

In addition, the range of products of ever has been extended by the application of higher pressures and copolymerisation together with other monomers. The construction of ever larger production units in association with much improved technique has resulted in substantial reduction of costs. The largest reactor units today achieve an annual output of some 30,000 tons.

Problems arising in connection with the planning, construction and operation of HPP installations in developing countries are discussed later.

I should now like to study the points raised more fully, placing most emphasis on the current state of high-pressure and process technology.

For PE polymerisation, which today is performed at pressures up to 3,200 atm., two different techniques can be considered, the so-called tube reactor and the autoclave process. To consider the advantages and disadvantages of these processes would claim the entire lecture and if we want to consider the present development position in this field it is to be left to be considered. As always there are advantages and disadvantages on both sides but questions of cost can be disregarded here since there are only insignificant cost

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SUMMARY

PRESENT SITUATION IN THE DEVELOPMENT OF HIGH-PRESSURE POLYETHYLENE PRODUCTION 1/

...presented by

...H. Imhausen

Imhausen International Company
Lahr
Federal Republic of Germany

...fter stressing the ever-growing importance of high-pressure polyethylene production, the two main techniques available are briefly discussed. Both the tube reactor and the autoclave method have their advantages and some of these are mentioned.

Safety, control techniques, service equipment and others are referred to. The increased production of co-polymers of ethylene is next mentioned and the use of co-monomers most recommended for developing countries.

Sources of ethylene, the raw material, are next dealt with followed by notes on some applications of polyethylene.

Training of personnel is referred to and it is generally concluded that high pressure polyethylene plants are quite suitable for erection in developing countries.

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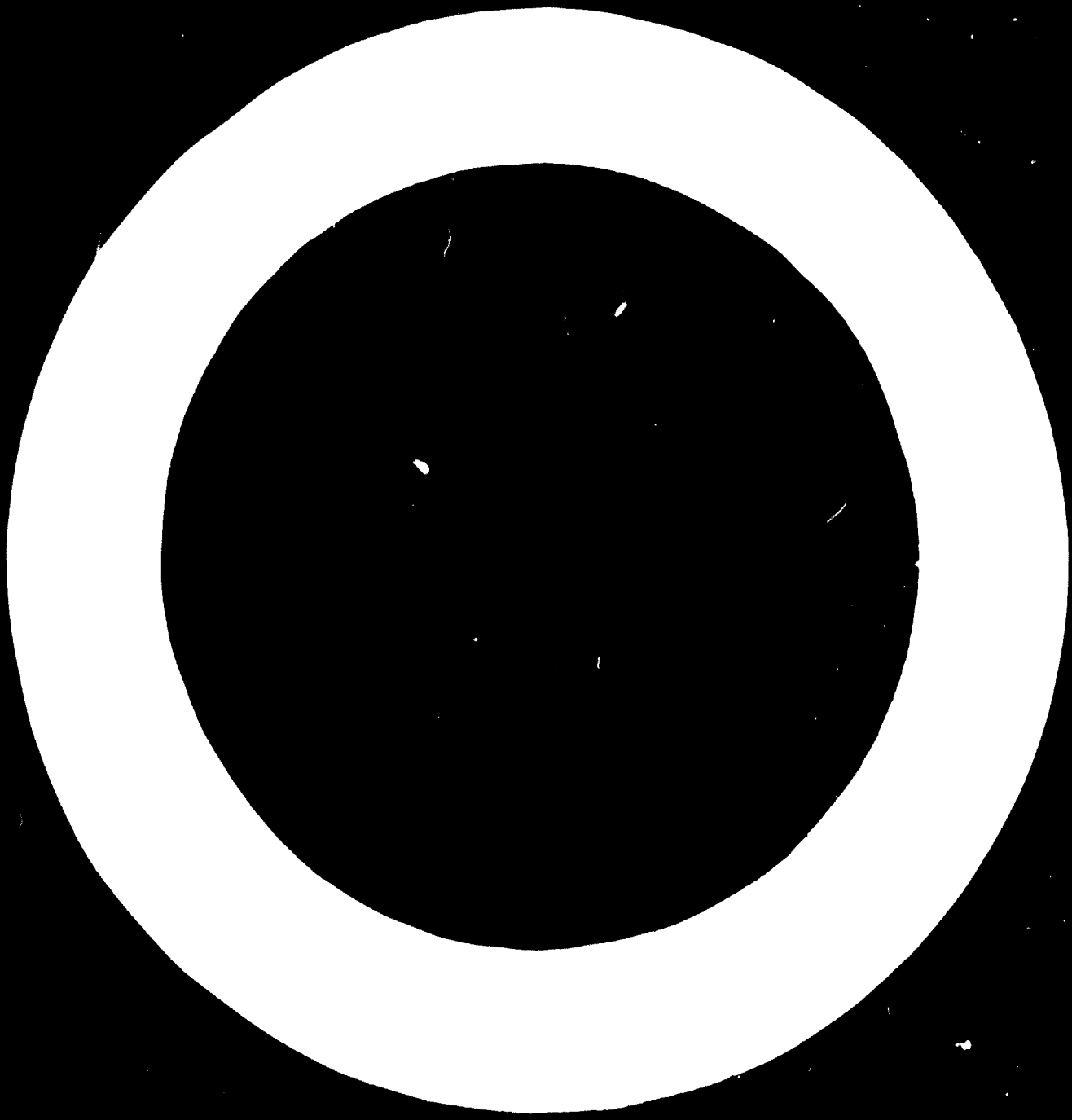

differences. Temporary distinct advantages of one or the other process during development over the past 20 years have all been neutralised by new developments so that [illegible] obvious advantages have disappeared. For example, the [illegible] in autoclaves [illegible] by feeding cold, fresh gas into the hot polymerization mixture has been compensated or exceeded [illegible] reaction zone of the tube reactor since [illegible] heat transfer [illegible] naturally [illegible] the relatively [illegible]. Moreover, the heat transfer [illegible] improved by the use of higher pressures. This phenomenon [illegible] explained by the fact that [illegible] certain pressure and temperature the ethylene/polyethylene mixture becomes more [illegible]. Since this phenomenon is also dependent on molecular weight and the PE has [illegible] molecular weight distribution, this will not occur entirely. In the ideal monophase system, i.e. the PE formed is fully dissolved in the ethylene, no [illegible] would form. In any case increase of pressure, in addition to its beneficial effect on product quality, results in a [illegible] improvement of the heat transfer to the [illegible] the tube reactor.

An [illegible] of the tube reactor is the absence of any moving parts, permitting among other things, simpler maintenance and cleaning.

The safety problem has been satisfactorily solved in both systems. In fact the autoclaves which occupy a larger volume expand so rapidly by the rupture of bursting discs that [illegible] exhaust [illegible] a closed flare system [illegible] to be impossible.

The current state of development in the field of HP polymerisation would be inconceivable without the advanced technical level of measuring and control techniques. Thus the problems of quantity measurement at high pressures, level measurement with thick walls, exact, uniform gas metering at high and low pressures and, above all, rapid, precise reproducible valve control according to pressure and temperature had to be solved.

The ever increasing size of polymerisation units necessitates the

construction of larger compressors and tubes or tanks. Established designs ensure long working life despite high demands. New lubricating agents had to be found which work efficiently even at high pressure and have no detrimental effect on the PE quality.

To extend the product range to special fields of application numerous tests have been carried out in recent years on the copolymerization of ethylene with other monomers, but from the large number of possible monomers only a few (vinyl acetate, acrylic ester, ethyl acrylate and acrylic acid) have proved to be particularly useful. The larger the reactor units become, the more is a restriction to inexpensive mass-produced products to be recommended without the use of costly co-monomers, difficult to store, and which in any case would have to be largely imported in the developing countries.

This lecture cannot fully cover the wide field of subsequent influencing of the PE quality by the addition of slip agents, anti-stock agents, anti-oxydants, anti-bacteria agents, fire inhibiting additives, the addition of fillers, blending with other polymers or subsequent cross-linking with peroxide and exposure to radioactivity.

Another interesting point in the field, the initiation of ethylene polymerization by gamma radiation, can likewise only be mentioned here. For the launching of large scale production, however, these tests are still not yet far enough advanced. The results are of special products with very high densities is already of interest however.

To turn now to the special problems of planning, construction and operation of HPP plants in developing countries I should like to consider first the raw material problem. Throughout the world and excluding refineries, large units in installations for the production of olefines from light naphtha as raw material are being built. The resulting gas mixture has an ethylene content of approx. 26-36% by weight. It is then usually separated in low temperature gas separation plants where, with a view to overall economic operation, all possible gases are collected and used for valuable intermediate products. A polyethylene plant will almost always

be connected to a cracking plant of this kind because of the large ethylene component.

These comments are independent of whether petroleum is available in the relevant country or whether a refinery exists.

For countries without petroleum but with very cheap molasses there is the possibility of producing ethylene from ethyl alcohol. Because of the relatively large investment required, however, the profitability of such an installation must be carefully studied. It is impossible, however, to predict the present development of the molasses price.

From the market point of view there already exists in most countries a large demand for polyethylene, the major part of which, up to over 50%, is required in the form of film for agricultural purposes and for the production of bags. To this may be added the manufacture of cables, irrigation pipes, blow mouldings and injection mouldings. Some industries are hardly affected at all. On the contrary, with the general shortage of wood the replacement of paper by PE bags is a lightening of the load. Suitable market research is to be recommended in each case before the beginning of planning work.

The operation of highly mechanised ICI plants, which I now wish to examine more closely, places relatively little demand on the actual control of the reactor owing to extensive automatic control and supervision of polymerisation. Most attention in these installations is devoted to maintenance of the equipment and the procurement of spare and replacement parts.

If tube reactors are chosen for the ethylene polymerisation there is no need to obtain peroxides as catalyst for initiation of polymerisation and hence storage problems do not arise. All products can then be produced using oxygen as catalyst, resulting in excellent quality, particularly of the film products.

For the support of operations during maintenance work the training of responsible engineers and particularly skilled workers such as fitters,

[illegible] restrictions [illegible] must be intensified. For [illegible] there [illegible] nothing to prevent the building and commissioning of HPF in-[illegible] installations [illegible] countries, [illegible] — [illegible] continent-[illegible] apart from [illegible] reported.

In conclusion [illegible] that the rapid development both in [illegible] technology [illegible] can in no way be considered [illegible] end. On the contrary [illegible] increase [illegible] worldwide [illegible] can be [illegible]ted.

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