OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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

D03715

Distr.
LIMITED

ID/WG.105/43
13 July 1972

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Seminar on Furniture and Other
Secondary Wood Processing Industries

Finland, 16 August - 11 September 1971

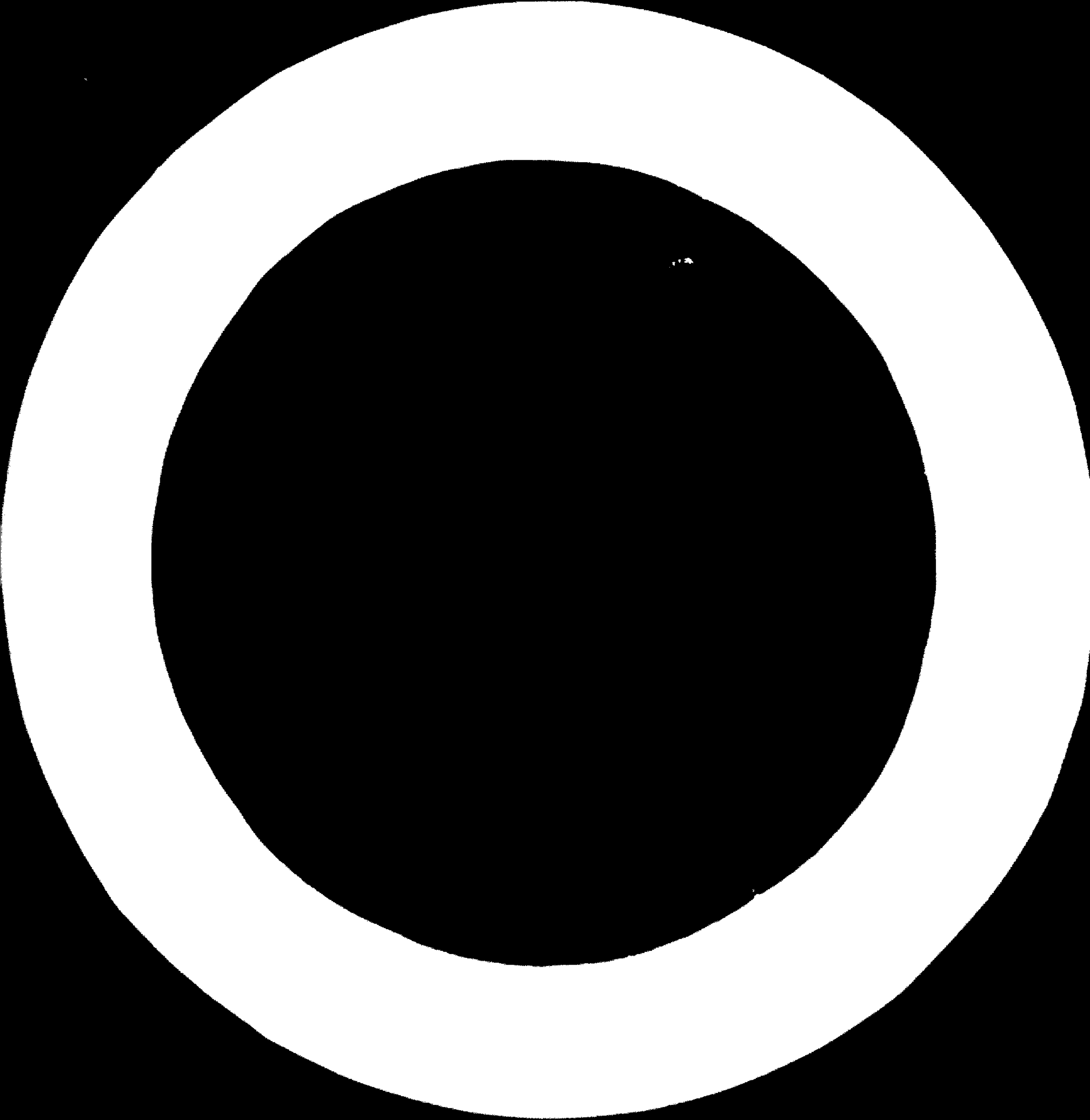
PLASTIC FOAMS[1]

by

Kristian Lindroos
Kouvala, Finland

[1] The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has been reproduced without formal editing.

id.72-1419



PLASTIC FOAMS

Kristian Lindroos

The production of organic polymers or chemical conversions of existing polymers is a rather new task in the history of mankind. But [illegible] the mouldability of polymers in their plastic stage [illegible] large variety of different plastics has been born. In the late thirt[illegible] the expansion by gases of polymers started. Today the technique allows almost every polymer to be foamed, [illegible] rather few foamed polymers have until now [illegible] importance.

It is possible to froth polymers by whipping in air and cure the foam, but generally the plastics are foamed using inert gases. CO_2 or N_2 are formed by chemical rection or decomposing of suitable chemical compounds. Also low boiling solvents are used as gas sources. The polymer may be cured with intact cellwalls or with [illegible] with closed cells is rigid and foam with open cells is flexible foam. The exeptions to this rule are of minor importance.

FLEXIBLE FOAM

The flexible foams (open cell) [illegible] a well established market. The yearly consumption in the industrialized countries lies at [illegible]. [illegible] grows 8 - 14 % yearly. Dependent on the structure of the industry [illegible], the furniture industry takes 40 - 50 % of the total consumption for upholstery purpose when bedding is excluded.

The flexible foams of commercial importance are.

polyurethane foam

PVC foam and

Latex foam

In Finland PUR stays for 90 % of all flexible foam. PUR is made of two main components a polyol and an isocyanate. They form a thermosetting resin at the same time as the blowing goes on. Depending on which polyol is chosen the formed plastic is called:

polyether (polyurethane) foam

polyester (polyurethane) foam or

" high resilient" polyurethane foam.

As thermosetting resins the polyurethane foam can be used over a wide temperature range. The polyether and "high resilient" foams are rather unaffected by chemical or oxidative attacks, but they swell in many solvents although they are not damaged by them. The polyester is not attacked by dry cleaning agents but may hydrolyse in warm and wet conditions, All polyurethane foams are easy to glue.

PVC foam is thermoplastic. It is inferior in all upholstery characteristics to PUR and latex foam but is easy to weld by high frequency radiation and has therefore a certain use especially in connection with PVC film. PVC cannot be glued.

Latex foam is a good upholstery material as long as it is properly protected against oxidation. However its share of the market has rapidly declined for commercial reasons and owing to the lack of self extinguishing characteristics.

STANDARDS

In general the foams are examined in accordance to certain standards such as ASTM, DIN, B.S. and SIS. The general standards are similar but the results cannot always be mutually compared. Some test results to be watched are:

Density

The volume/weight of a foam gives of course the amount of material considered to carry the upholstered load. In PUR the volume/weight may be given as " bun " density or core density. In "bun" density the skin is included. For slab stock, PUR foam core density lies about 2 kg/m^3 below "bun" density. A tolerance of $\pm$ 1,5 kg/m^3 in core density is normally allowed.

Load bearing characteristics

The indentation hardness is a measure of the load-bearing properties of a foam.

There is an international recommendation R 19 and R 56 made by ISO/TC 45 to characterize the deflection under load. The test is carried out by special equipment for several indentations, usually the loads for 25 %, 40 % and 65 % deflections are reported. The hardness is rather independent of the density and has hardly any influence on the lasting properties.

A useful figure for comparing different foams is obtained by dividing the load at 65 % indentation by the load at 25%. This gives a measure of the comfort requirement as the users want a soft foam with high load-bearing qualities. i.e. rapidly decreasing hardness below 30 % indentation but an increasing hardness above it.

Permanent set

In a simple way the permanent set gives an important figure for the actual quality of a foam. It gives a description of the degree of cure. The test is described in detail in the preliminary recommendation R 81 made by ISO/TC 45. A specimen is simply

compressed by either 50 %, 70 % or 90 % for 22 hours at 70^{0}C and the loss in height is measured. At 70 % compression a good foam should not lose more than 10 %, in some cases a 15 % loss is acceptable.

There are several other tests made for plastics foam which may be of importance especially in certain applications.

Tensile strength and elongation at break are measured in accordance to ASTM D1564

Tear strength can be measured by ASTM D 1564

Steam ageing which gives the degradation in humid conditions, ASTM D1564

Flexing test is usually carried out to 250.000 cycles ASTM D1564. The indentation hardness loss caused by flexing gives a figure for one of the biggest weaknesses in PUR foam.

Breathability, DIN 52213, gives figures for the amount of closed cells in a flexible foam. Comfort demands high breathability.

Self extinguishing test ASTM D 1692 is needed when a certain degree of fire resistance is demanded.

Ball rebound test ASTM D 1564 gives the resilience of foams.

RIGID FOAMS

Rigid foams are used for thermal insulation [illegible] structural [illegible]. The foam used for insulation and packaging have densities of 12 - 40 kg/m^3. Th structural foams are used in densities from 40 kg/m^3 upwards The most common rigid foams are:

- rigid polyurethane foam
- expanded polystyrene
- duromer type polyurethane foams
- structural polystyrene and similar
- structural polyolefins

All rigid foams have closed cells. Of the mentioned types only polyurethane is a thermosetting resin, the other are thermoplastic. Both rigid polyurethane and expanded polystyrene are used in furniture in densities 40 - 80 kg/m^3. Due to the low densities relative thick walls as well as inserts for bolts, screws and nails are needed. Gluing to polyurethane is easy but polystyrene demands very carefully chosen glues.

The duromers are used for decorative details and structural purposes. They have tight skins and [illegible] cores. The overall density of the duromers is 200 - 600 kg/m^3.

A new development in the plastic field is the use of long known thermoplastic resins slightly expanded by gases for structural application. The benefits of structural polystyrene and polyolefin foams are in the production technique which allows an economic mass production of big items, such as chairs and furniture parts.

EQUIPMENT

Foams are made by continuous methods as well as by batch moulding. The plastics foamed continously have to be cut afterwards

wards [illegible] The shape is given by a mould.

Polyurethanes are produced from [illegible] components which are mixed in a mixing head. For trial purposes the components can be handmixed. In moulding the mixing equipment used has minimum capacities below 60 kg/ min. The mould filling time must not exceed 5 - 10 seconds, depending on the recipe. The main part of the flexible foam is produced as slab stock by continous foaming. The foam is later cut by band knives but oscillating knives are also used.

Expanded polystyrene is also foamed continously by extruding equipment or moulded by special moulding machines.

The structural polystyrene and polyolefins with higher volume weights are moulded on specially designed injection moulding machines.

LITERATURE:

Polyurethane. Kunststoff Handbuch Band VII, München 1966

D. Homann: Kunstoff-Schaumstoffe, München 1966

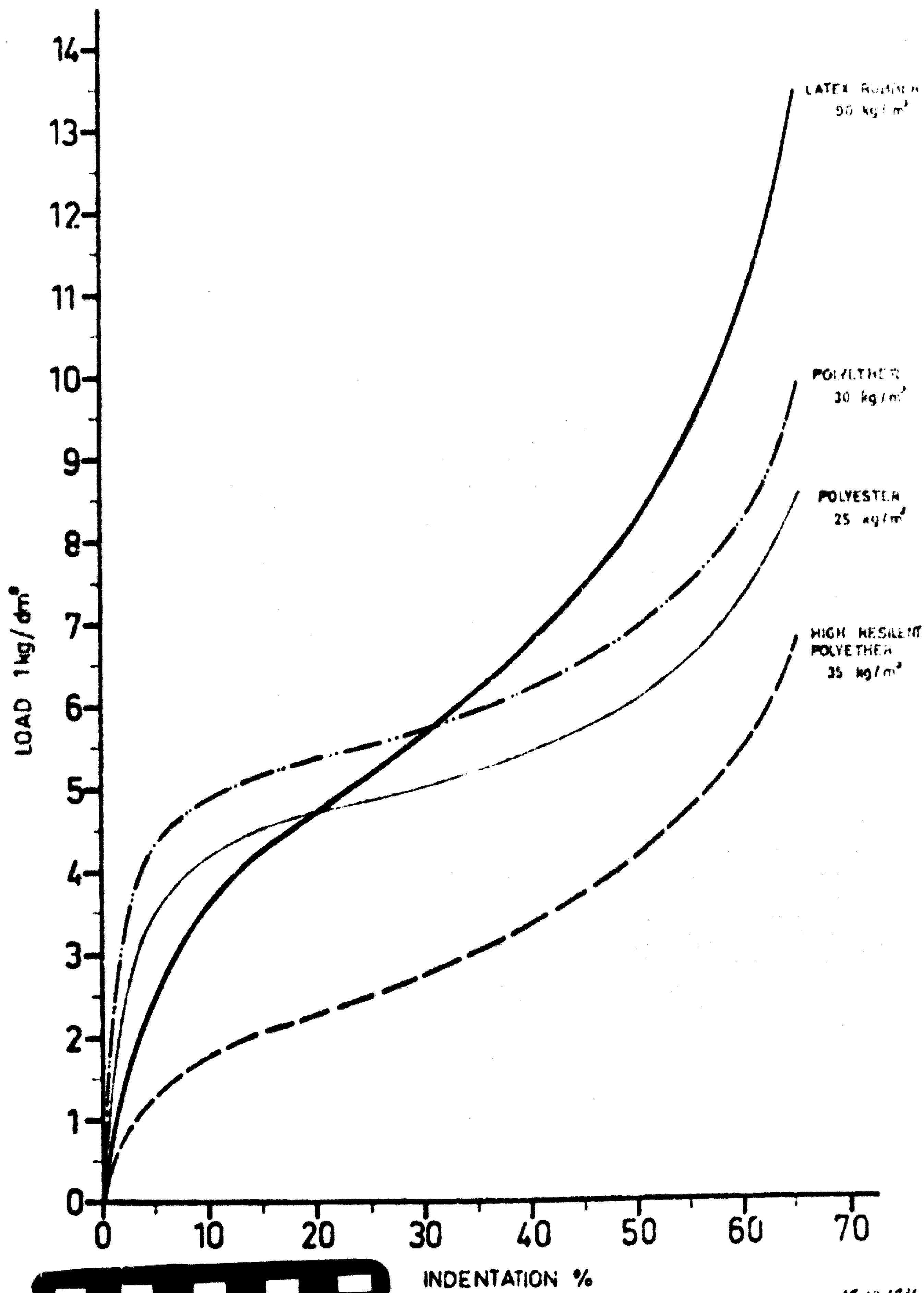
J.M. Buist and H Gudgeon: Advances in Polyurethane Technology, London 1968

H. Piechota: Urethane Duromer. Paper at cellular Plastics Conference New York 1968

AC Morris and J Czeski: Some resent developments in thermoplastic foams. Paper at Scanplast Conference Gothenburg 1969

R.L. Grieve & Co.: A new Generation of Structural Foam Polymers, Journal of Cellular Plastics 6. no. 4 1970

HARDNESS CHARACTERISTICS FOR POLYURETHANE AND LATEX FOAMS



16. 7. 74