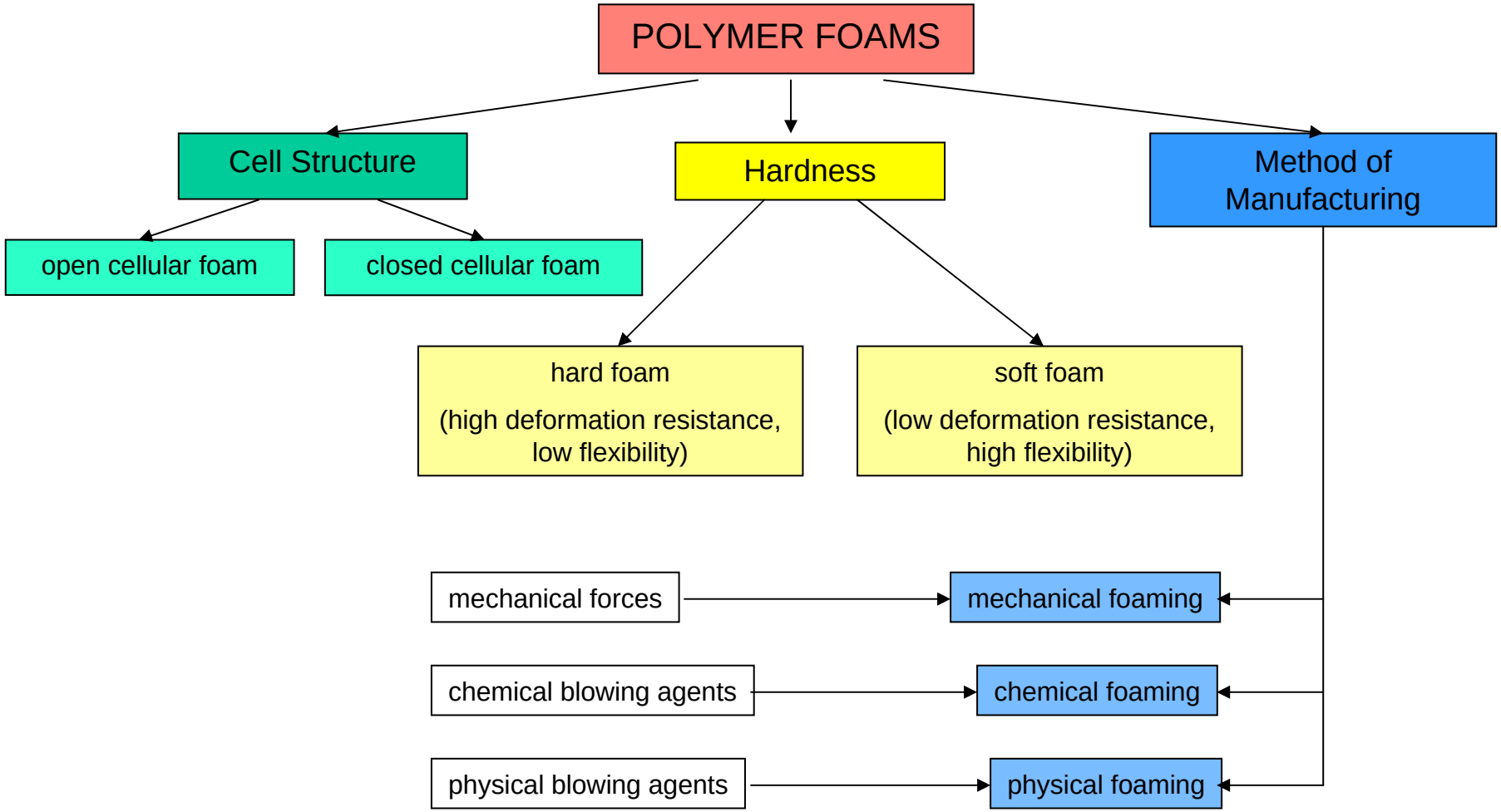
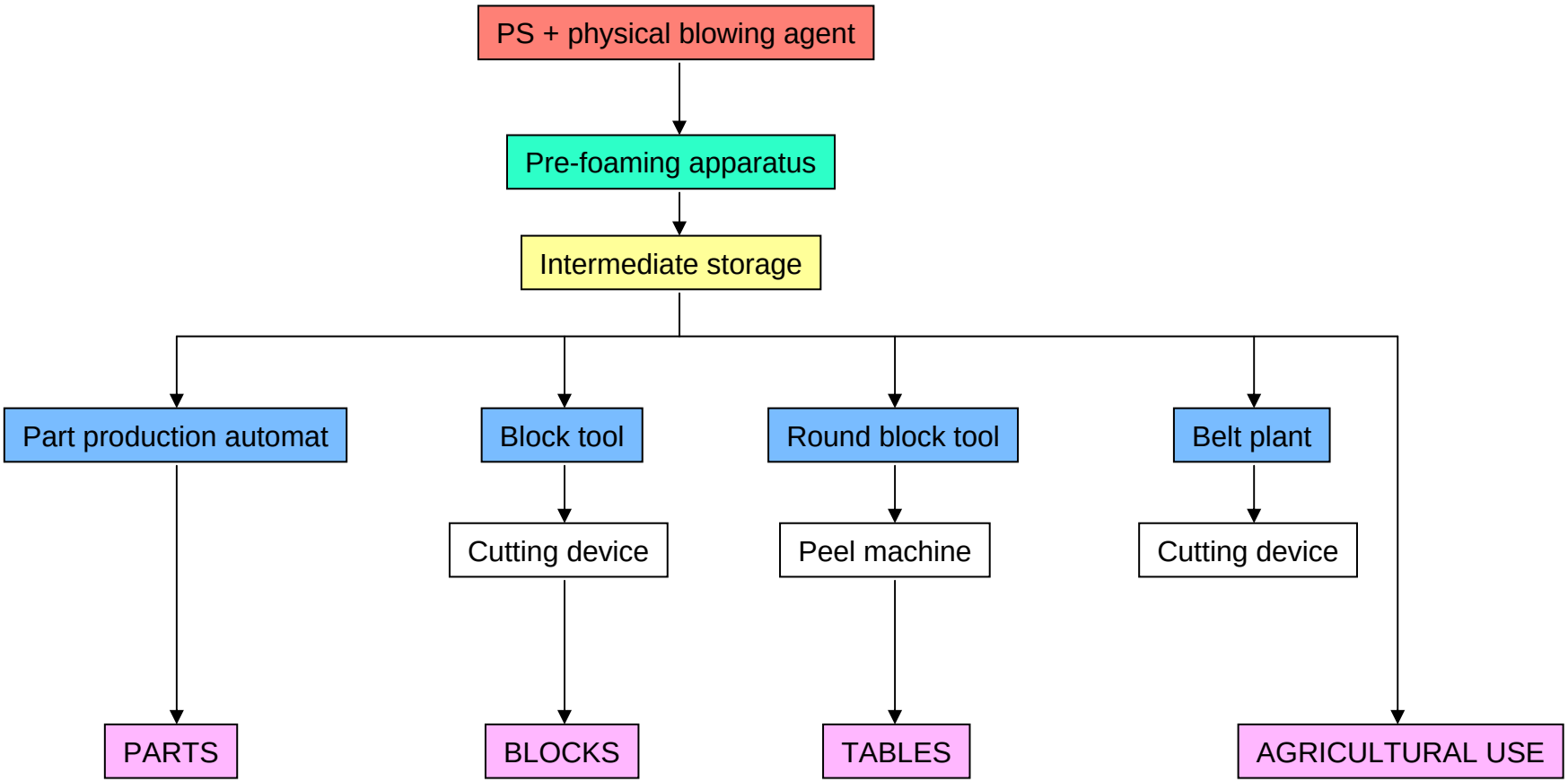


Classification of polymer foams

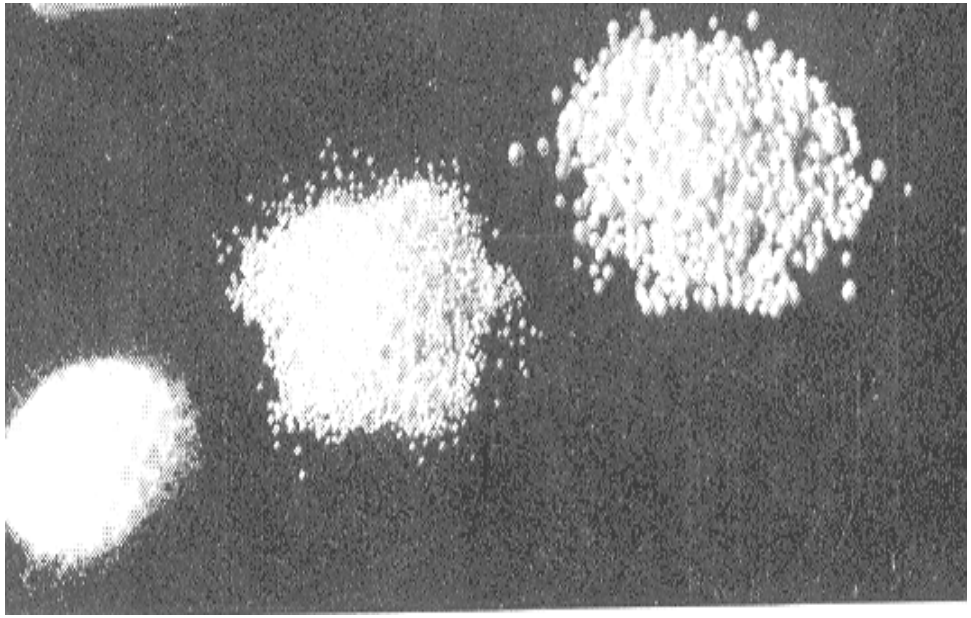
Classification of foaming methods and important blowable polymeric materials

Foams / ***Initial material***	***Foams with eaquilized density deviation***		***Integral foams***	
	Method	***Material***	***Method***	***Material***
thermoplastic melts	Extrusion Compression molding Calendering	PS SB ABS PVC PE	Extrusion Injection molding Calendering Mold foaming	PS SB ABS PVC PE PC, PPO
blowable particles, paste	EPS technology PVC paste foaming	PS PVC	-	-
reactive liquid initial components	Continuous or discontinuous foaming in molds or conveyor belts or free foaming	PUR, PF, UF	Reaction mold foaming	PUR

EPS Technology

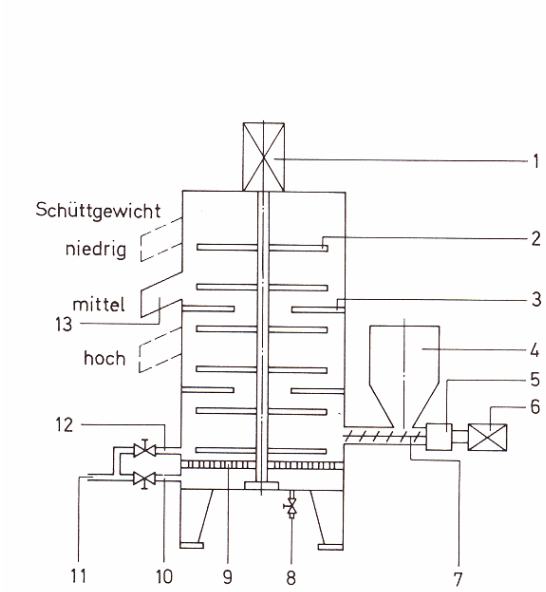


EPS Material



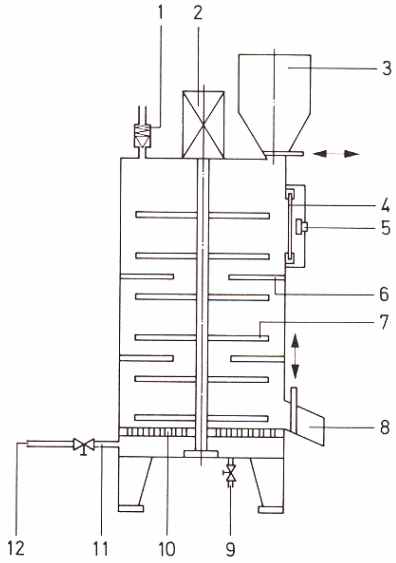
Pentane loaded PS Pre-expanded PS Expanded PS

Pre-foaming Apparatus



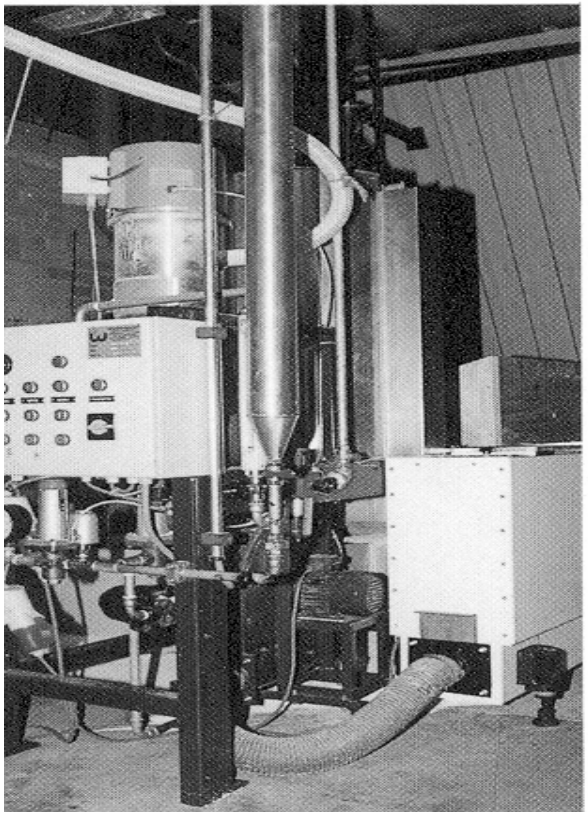
1 *stirrer engine*
2 *stirrer*
3 *breaking blade*
4 *feeder*
5 *gear*
6 *screw driver*
7 *feeding screw*
8 *condensate outlet*
9 *sieve bottom*
10 *bottom vaporizing*
11 *vapour inlet*
12 *side vapourizing*
13 *outlet shaft with height regulation*

Continuous pre-foamer

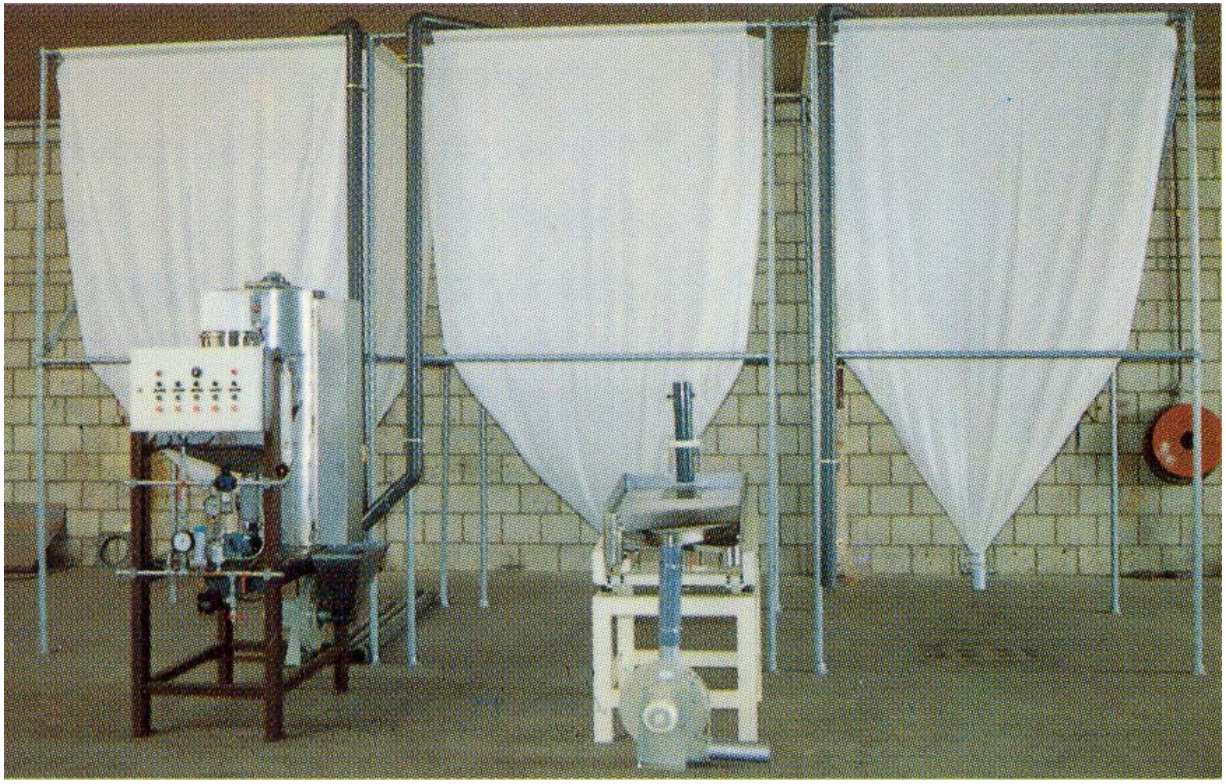


1 *security valve*
2 *stirrer engine*
3 *feeder*
4 *control glass*
5 *control equipment*
6 *breaking blade*
7 *blade stirrer*
8 *outlet shaft*
9 *condensate outlet*
10 *sieve bottom*
11 *bottom vaporizing*
12 *vapour inlet*

Discontinuous pre-foamer



Intermediate Storage

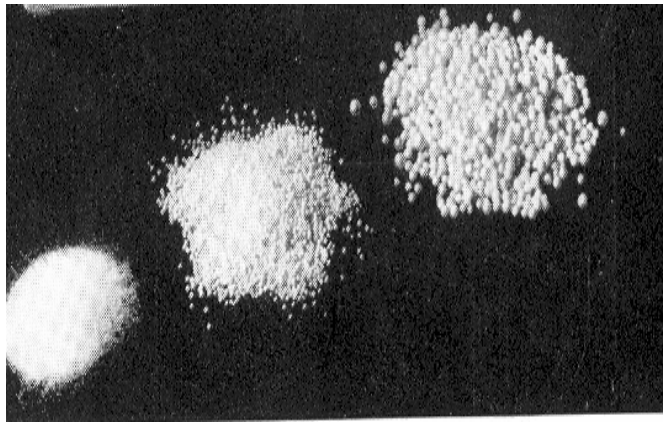


Stabilization of cellular structure

- Diffusion of blowing agent
  out of the cells

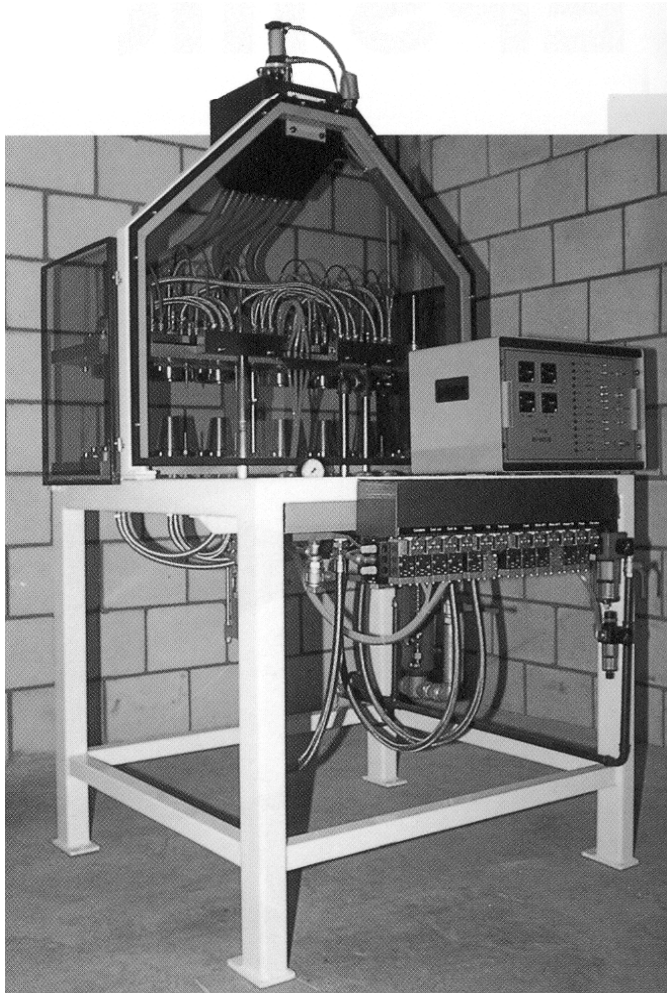
- Diffusion of air into the cells

EPS Technology

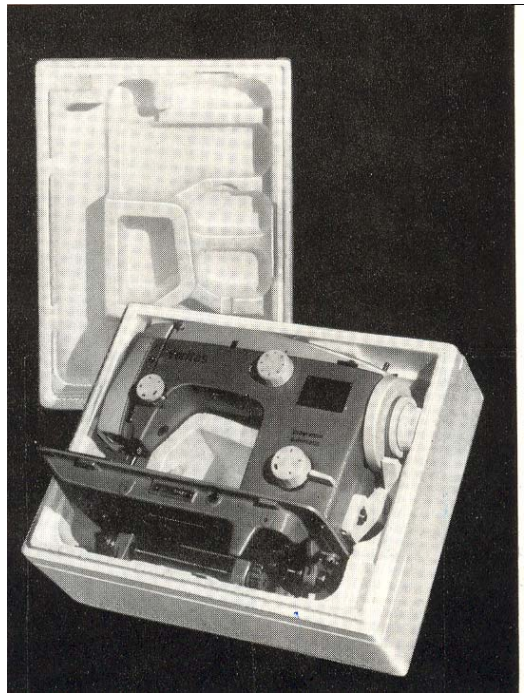


EPS Material

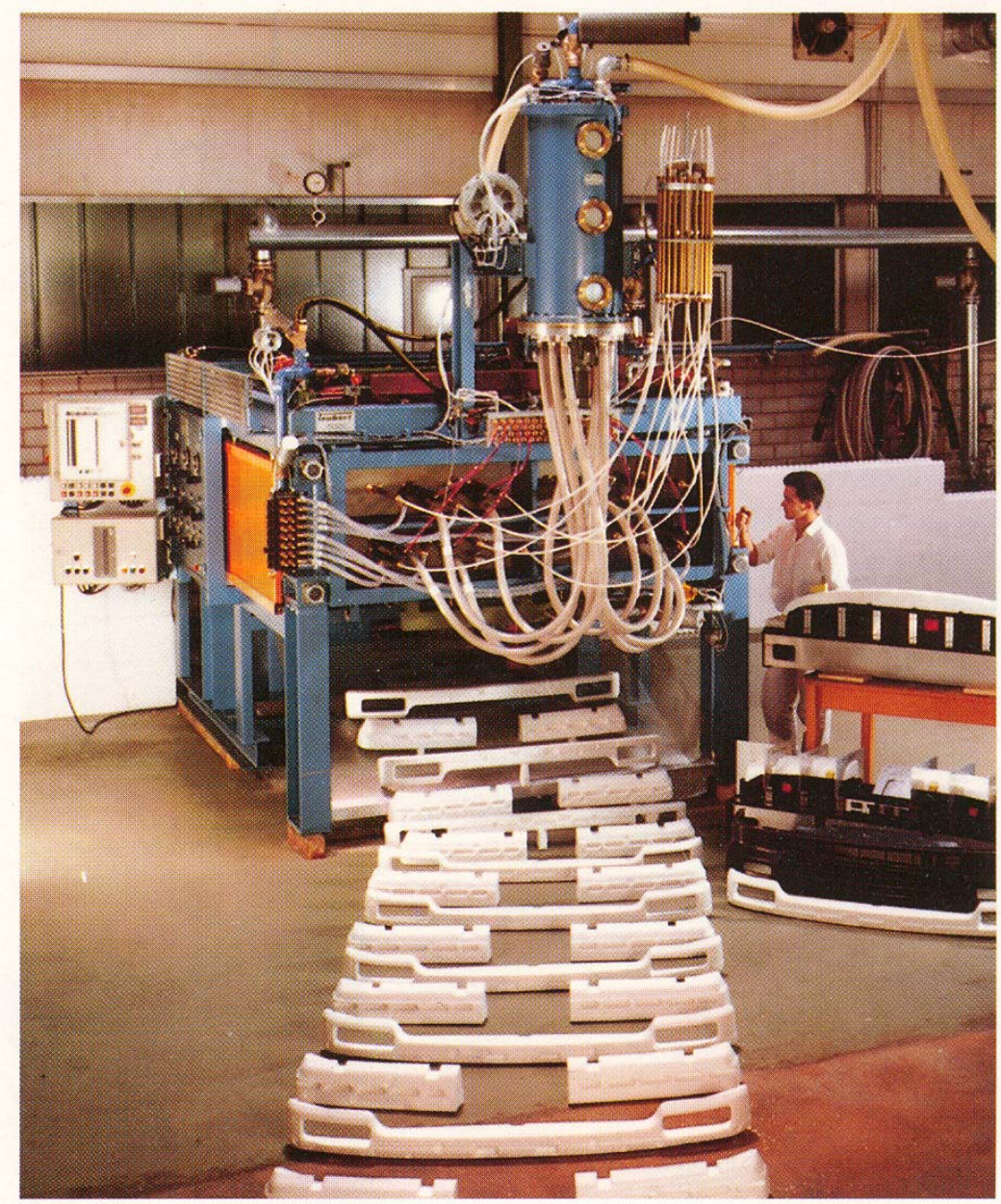
Pentane loaded PS **<u>Pre-expanded PS</u>** Expanded PS



EPS Molding Machine



EPS Product for Packaging

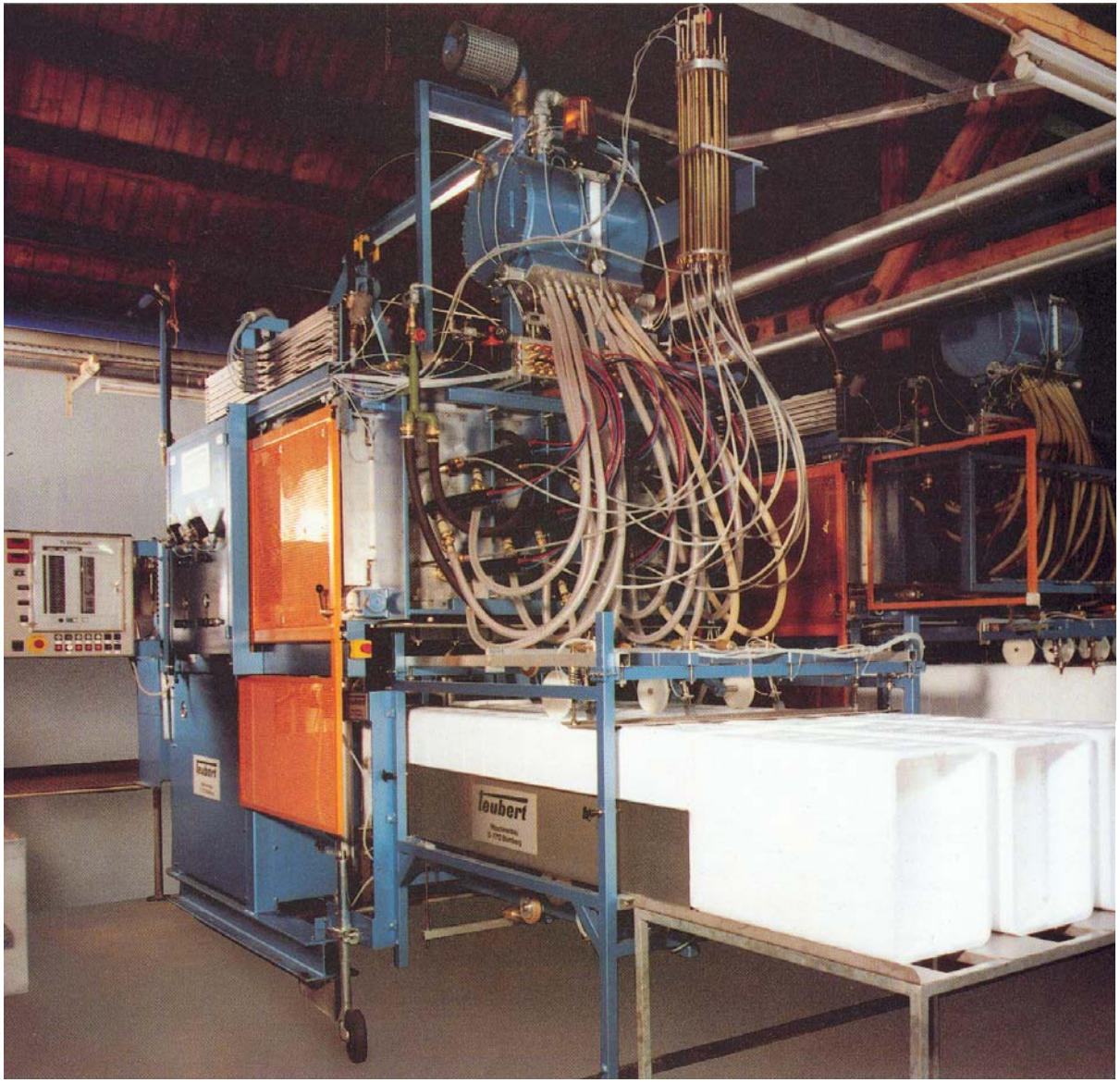


Bumper Production

EPS

EPP

EPE



EPS Block Production

POLYURETHANE

ALCOHOL + ISOCYANATE ⟶ URETHANE GROUP

R´ - OH + NCO - R ⟶ R - NH - CO - O - R´

Wurtz 1849

DI-ALCOHOL + DI-ISOCYANATE ⟶ POLY URETHANE

HO - R´ - OH + OCN - R - NCO ⟶ - O - R´ - O - CO - NH - R - NH - CO -

Polyaddition

Bayer 1939

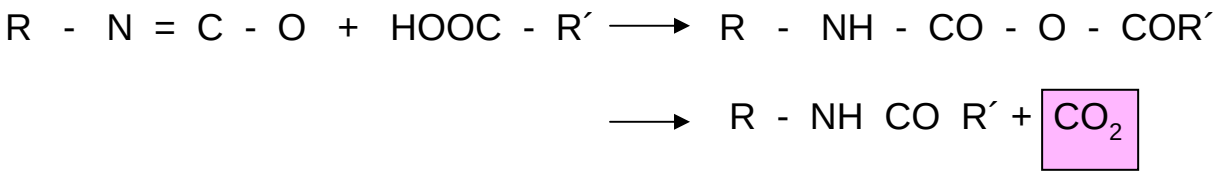
PUR FOAM Generation

polyole + water and/or liquid blowing agent + catalyst

+

poly (isocyanate)

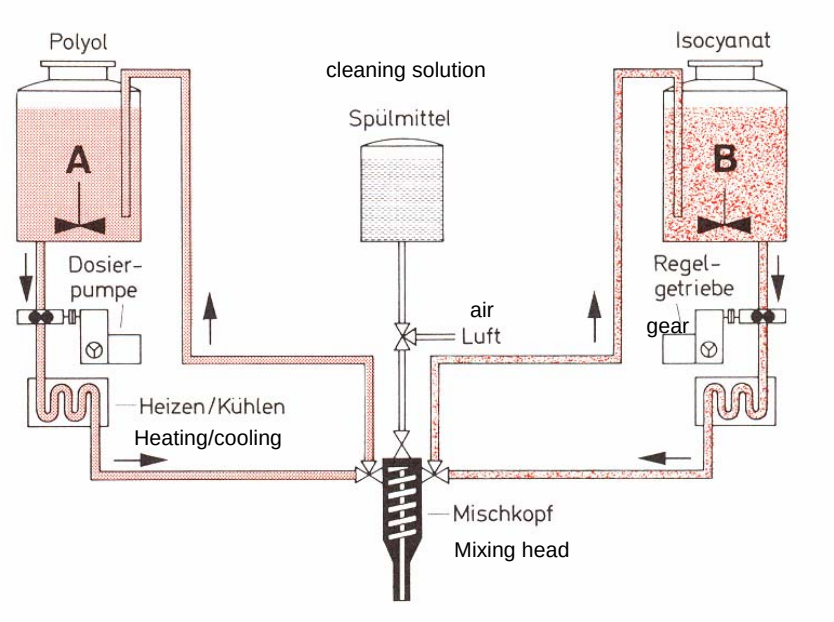
poly (urethane) foam

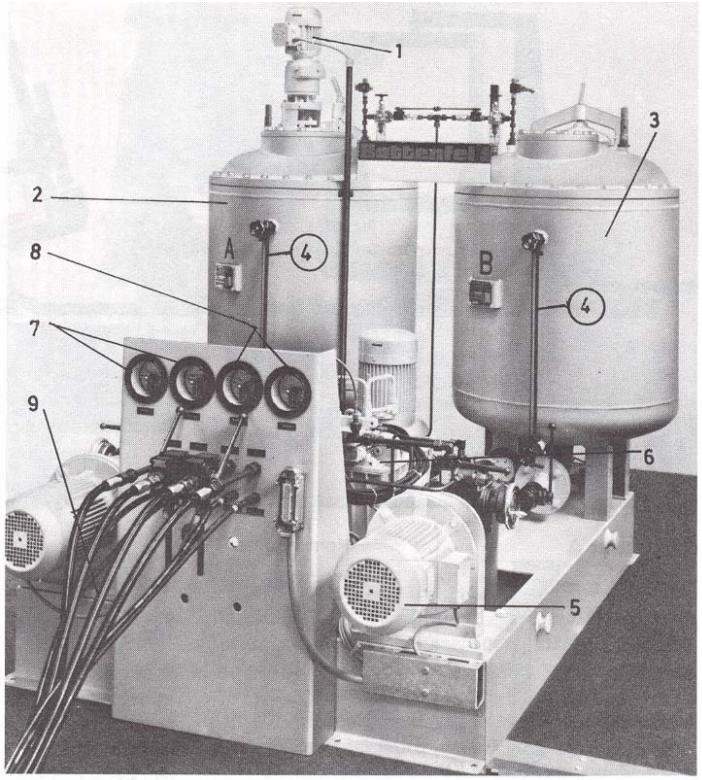


WURTZ 1854 !
Hoechtlen/Droste 1940 (Leverkusen)

„mistake“: carboxy group in polyester

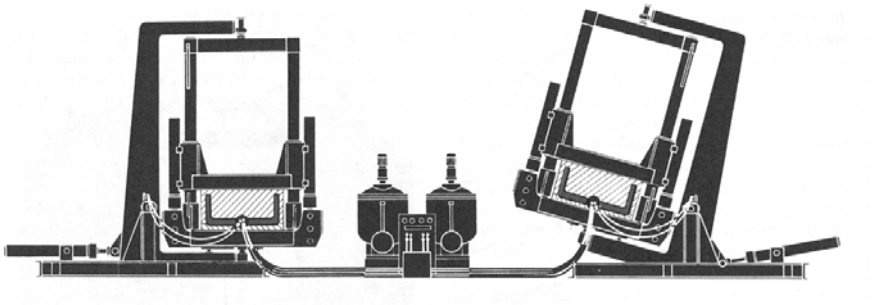
PUR FOAMING



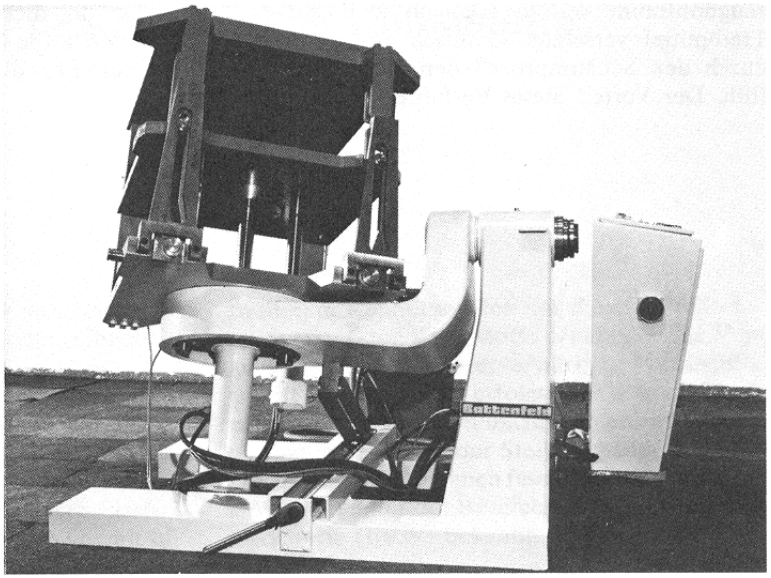


1 stirrer for polyole
2 double wall container for polyol
3 double wall container for isocyanate
4 filling control glasses
5 feeding unit for polyole
6 hydraulic device for mixing head driving
7 pressur control polyole
8 pressure control isocyanate
9 components pipeline to mixing head

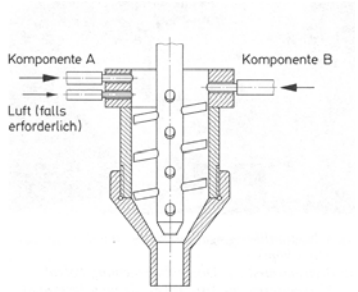
PUR Foaming
Reaction Injection Molding



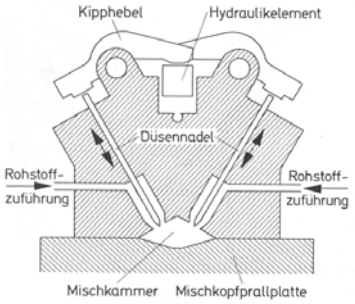
Injection device



PUR mold carrier



Stirring mixing head



Injection mixing head

PUR plates production by floating top-paper procedure

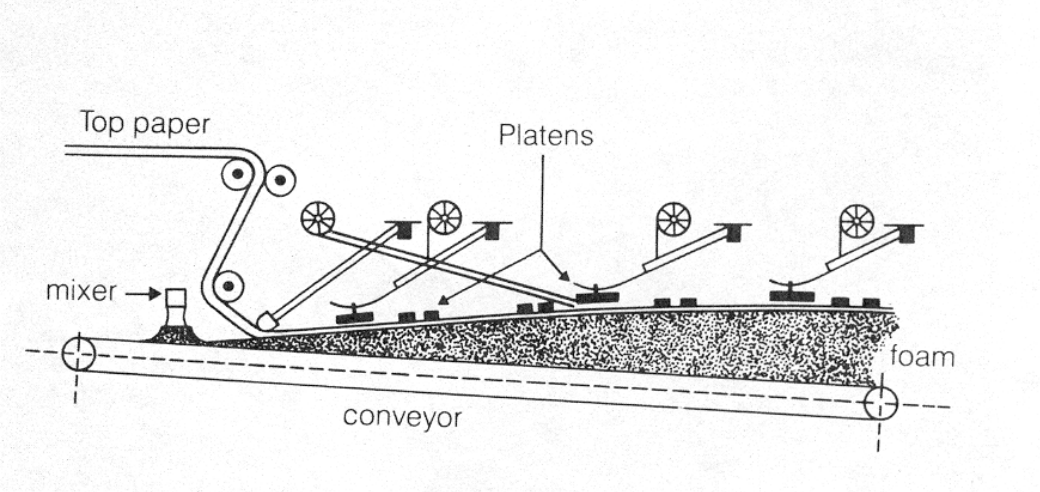


Table 4-3 **Typical formulation for making polyester-based flexible foam (slabstock)**

Component	**'Technical' grade foams** (parts by weight)			**Laminating grade foams** (parts by weight)			**Formulation range**		
'Daltorez' SF	100	100	100	100			100		
'Daltorez'RB4	–	–	–	–	100	100	100		
80:20-TDI (Index)[3]	–	–	105	90	90	100	85	to	100
65:35-TDI (Index)[3]	105	105	–	–	–	–	85	to	115
Water	5.0	3.0	3.7	3.6	3.6	3.8	2.0	to	5.2[1]
'Lubrol' SF2	1.0	1.0	1.0	1.0	1.0	1.0	0.7	to	1.0
N-Ethyl morpholine	–	–	2.5	1.3	1.5	2.0	1.0	to	2.5
N-Dimethlcycolohexylamine	0.8	0.6	–	0.05	0.1	–	0.01	to	0.9
N-Dimethylcetylamine	–	–	–	–	–	0.28	0.01	to	0.4
Polyurax Silicone[2] SE-232	–	0.7	–	0.9	0.8	1.0	0.6	to	1.0
Polyurax Silicone SE-236	0.8	–	1.0	–	–	–	0.6	to	1.0
Flame retardants	–	–	8.0	–	–	–	2.0	to	15
Pigments/dyes	0.05	0.05	0.05	–	0.01	0.05	0.001	to	5
Foam density (kg/m^3)	20	33	29	30	29	26.5	17	to	40

[1] The maximum safe level of water depends on the formulation used, the scale of manufacture, the ambient conditions and other factors affecting the maximum reaction temperature (See Chapter 10).
[2] Or equivalent materials, Niax Silicone surfactants.
[3] The amount of TDI used is expressed as the 'TDI Index' (see page 62).