Ram Extrusion

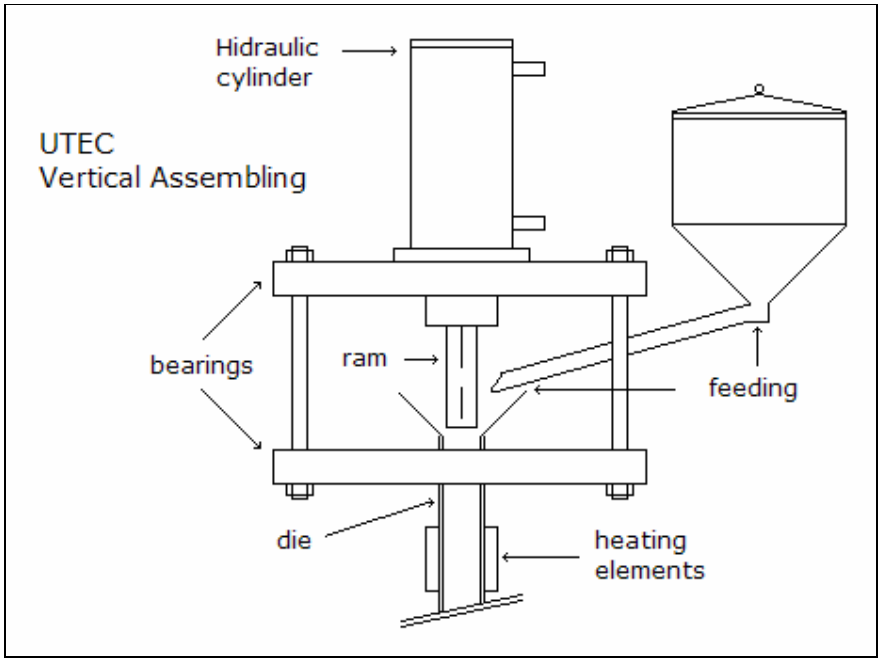
The Ultra High Molecular Weight Polyethylene (UHMWPE) – UTEC® can be molded by a cyclic compression sinterization technique, where the final product is a continuous profile. This technique is known as Ram Extrusion. Conventional screw extruders can not be used to process UTEC, once it does not flow in the molten state.

PRINCIPLE

The raw material powder is fed in the machine by a hopper and is packed by a ram in successive increments. The ram movements, as well as its amplitude and frequency, are derived from a high-pressure hydraulic system. The packed material is pushed along the heated die, whose internal section determines the profile final shape.

The production rate is determined by the heated die zone length, the ram step, and the regularity in the ram movement.

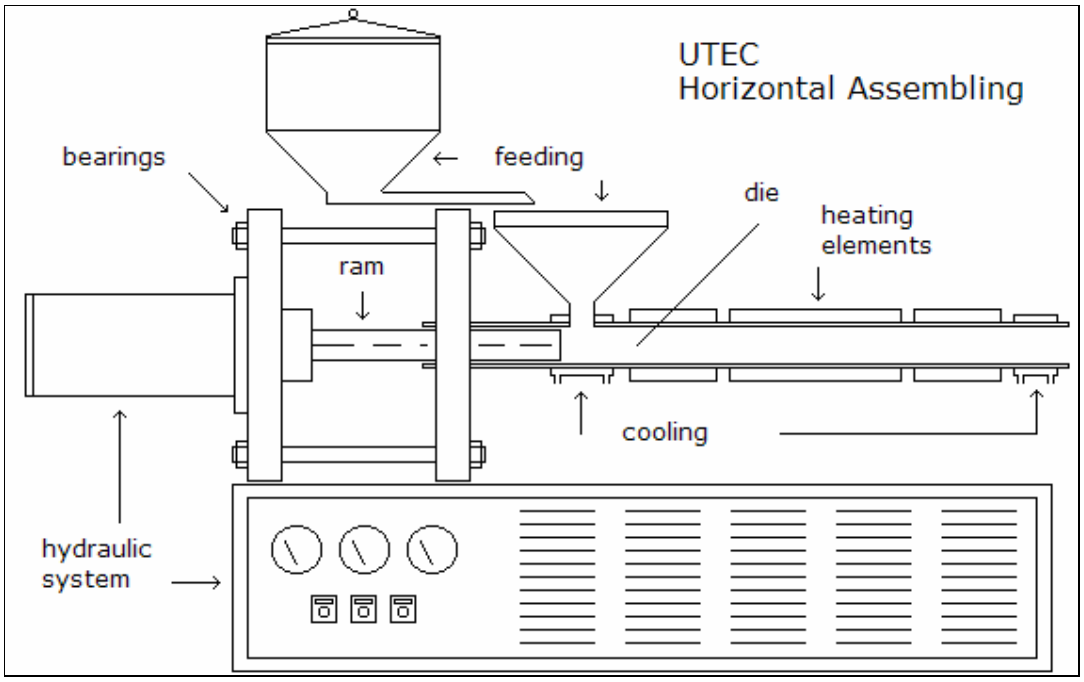
The determinant factors for productivity and the quality of the extruded part are: the power of the hydraulic system, capacity of the electric resistances, length of the heated die zone, and mainly the mechanical resistance of the involved components on the extruder construction.



Ram Extrusion

EQUIPMENT

The basic equipment is mounted from two parallel steel plates that are firmly connected one to each other through spacers which are robustly designed to resist the great forces involved in the process. In the superior plate, a hydraulic cylinder is mounted, and, in the lower plate, it is mounted the mold or the die. The basic disposal can be vertical (picture above) or horizontal (picture below). In the vertical assembly, the raw material feeding is more uniform and tends to provide a product of better quality, while the horizontal line allows the production of larger parts.



HYDRAULIC SYSTEM

It must be designed for the largest profile considering the highest desired productivity. In most cases forces between 10 and 100 tons are used. For profiles with larger dimensions, it can be necessary forces in the order of 500 tons. Generally, the system consists of one reservoir, an oil pump with circulation system, a hydraulic cylinder and valves of outflow and flow control.

DIE

It is the most important and expensive part of the UHMWPE – UTEC® extrusion process. It must be built with a structure sufficiently strengthened to resist the great pressures

generated internally. It's generally used a steel of low coefficient of thermal expansion, with inner section in the same shape of the profile and carefully polished internal surface. The thin wall profiles are the most difficult to be processed because of the high internal pressure. In that case the production is limited by the steel resistance.

The die length must be determined in function of the desired productivity and can reach 4 meters. In the vertical assembly, the feeding of the raw material powder is normally made when the piston goes up and opens the superior entrance.
For the horizontal assembly, the powder feeding is made through a lateral opening. The die heating is made through external mounted electric resistances. The feeding zone is cooled to prevent imperfections in the feeding by the powder agglomeration and formation of bridges.
The table below shows the relation between rod diameter, heated zone minimum length and productivity.

Diameter mm	Production kg/h	Force ton	Heated zone length (m)
25	5	5	2
50	10	20	4
75	10	30	4
100	10	40	4
125	10	50	4
150	10	60	4
200	10	80	4

Table-1 Typical examples of dies used for production of circular section profiles.

RAM

It must be firmly fixed and lined up in the tip of the hydraulic cylinder rod. In most cases it is made of bronze, and it has the same shape of the extruded profile. The gap between the die and ram must permit the air escape during the powder packing, and must be 0.1mm, maximum.

HEATING

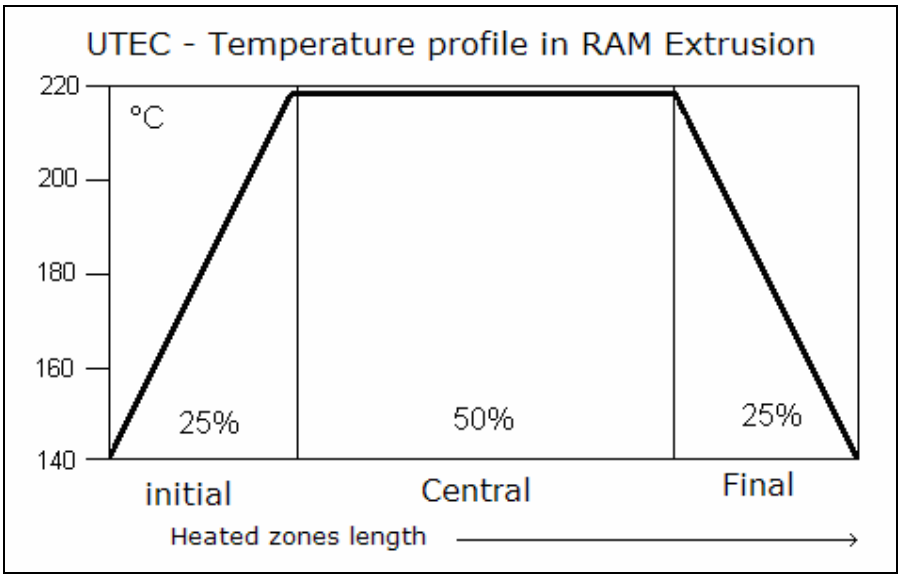
The electrical resistances are disposed in three zones arranged in a way that the initial covers 25 %, central 50 % and the last one 25 % of the heated area. The control thermocouples must be located in the center of each zone. The power of the electric resistances is calculated in a way that to have 1 kW by kg/h of production.

Ram Extrusion

Zone	*Temp. (°C)*	*% total*
Initial	160-180	25
Central	200-220	50
Final	160-180	25

PRESSURE

The force that the piston exerts on the powder for packing and advancement is a combined reaction of two basic components. The first is generated by the unmolten packed powder, and the second by the viscosity of the molten resin in contact with the die wall. A profile of significant flow does not exist, practically all the section moves with the same speed. When the packing initiates, the generated counter pressure strongly increases until the static friction limit. When the static limit is surpassed, the profile is pushed forward with a lower force generated by the dynamic friction.



EXIT

The extruded material must be cooled with a minimum restriction of the advancement. It is better to let it over a roll mat. A better superficial finishing can be obtained with the use of an air ring in the exit, and/or with the cooling of the die tip using water circulation.

PROCESS ADJUSTMENTS

In the ram extrusion process, all molding phases (feeding, packing, melting, cooling, and advancement) occur at the same time, and therefore it is necessary a careful adjustment

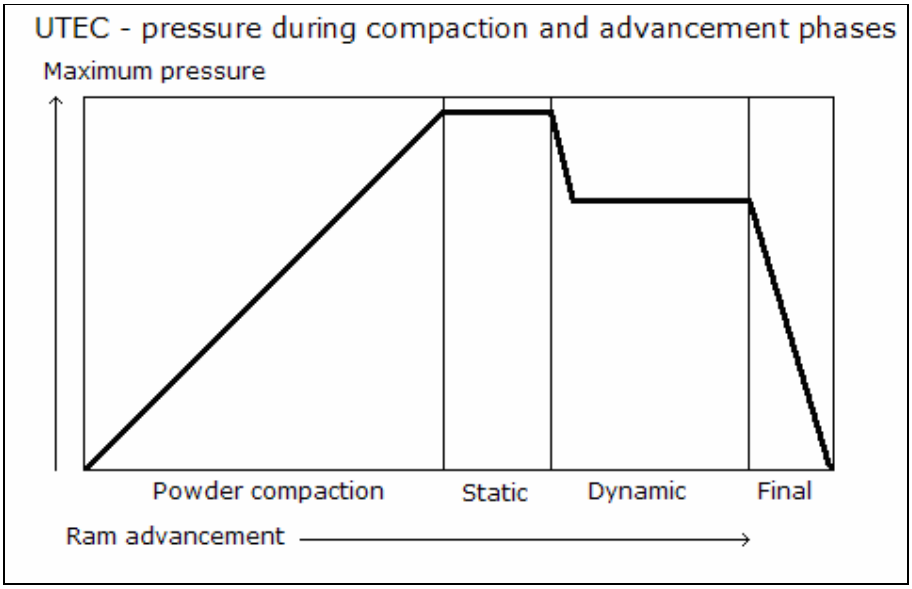
of each parameter. Generally, the following issues must be observed:

- Relationship between temperatures and speed
- Relationship between feeding volume and packing frequency
- Ram advance speed
- Profile of heating temperatures
- Ram and feeding zone cooling
- Extruded cooling uniformity

PROBLEMS

The main problems that may occur in the process and in the extruded product quality are generally caused by:

- Lack of temperature uniformity around the die
- Deficiency in the powder raw material feeding
- Insufficient polishing on the internal die surface
- Low resistance mechanical structure



Note: The information contained herewith is merely informative. It is presented in good faith and expresses the truth based on the current acquired knowledge. They do not imply in any guarantee of result or performance.