# Plastic resins – what goes into tubing and why

**(Reprinted with permission, Drainage Contractor Magazine, Winter 1986)**

In Europe, PVC (Poly Vinyl Chloride) has been the material traditionally used for drainage tubing. But more recently, the Europeans have been following the lead set by North America in using high density polyethylene (HDPE), particularly the British Isles and Scandinavia.

Other materials have been tried too. During the mid 60's, an attempt was made by Amoco Chemical to use high impact polystyrene, more recently in Canada, an attempt was made to utilize copolymer polypropylene and this did meet with some commercial success in Quebec.

High impact polystyrene can be immediately eliminated as being totally unsuitable due to cost, lack of impact strength, flexibility and, with the advent of "maxi-coils", its lack of coiling ability.

PVC is a material in abundant supply, competitively priced and used in many areas closely related to drain pipe: siding and smooth wall pipe are just two examples. Two things conspire to eliminate PVC from the corrugated market here in North America.

Firstly, the resin must be modified to improve impact strength, stress crack resistance and flexibility at low temperatures. These additives, while being commercially available increase the cost dramatically. Secondly, PVC must be completely cooled before coiling or the pipe, when laid in the field will just recoil again.

Polypropylene, on the other hand, has some distinct advantages over polyethylene. Environmental stress crack is not a problem with polypropylene; it actually becomes stronger with flexing. It is lighter and stiffer than HDPE, but is more expensive. The down side for polypropylene is cold crack; homopolymer polypropylene starts to turn brittle at zero degrees C (32 degrees F). The use of copolymer polypropylene, modified with either ethylene or thermoplastic rubbers, reduces this problem, but of course increases the cost.

HDPE is uniquely suitable for use in corrugated pipe. Low temperature strength holds right through minus 76 degrees C (minus 105 degrees F) long after most contractors have already decided that it is too cold! Its impact strength is similar, holding over a wide temperature range. It is easily processed and is readily available.

The drawback is the much discussed stress cracking. Simply put, stress cracking is the appearance of cracks internally or externally, and this failure of the polymer. If stress cracking is inherent in the raw material, how can the problem be minimized?

The two most universally talked about properties of polyethylene are melt index and density. Melt index is a simple test of flow rate, or technically, the amount of material that flows through a fixed orifice at a fixed temperature, under fixed pressure in a set time. Density is the specific gravity of the material.

The ideal polyethylene for corrugated pipe has a density of between 950 and 960, and a melt index below 1.0. The further you deviate from these ideals the higher is the risk of stress cracking showing up.

Up until late 1983, Canada had three producers of the fractional melt high density polyethylene suitable for drain tile. In the fall of 1984 the three long established producers, Dow, DuPont and Union Carbide were joined by not only a new competitor, but one using a whole new process.

Imperial Oil's new plant located in Sarnia, Ontario is using a technology invented by and licensed from the union Carbide Corporation, know as "Unipol". This process, while being primarily designed to run low density polyethylene for film resins has the capability of running high density polyethylene. Esso Chem announced its intention to run HDPE late in 1984 or early 1985, but has not as yet disclosed marketing plans, or grades to be produced.

Later on in 1985 Novacor brought on stream a new reactor, also using Unipol technology, but located in Alberta. This unit will have the same capacity to run high density as the Esso Chemical plant. Novacor incidentally, because of its location in Alberta, virtually guarantees the supply of feed stock at very competitive prices.

The low density polyethylene market will determine not only how quickly, but also to what extent both of these new producers will produce and market HDPE. There is a very healthy complement of potential suppliers, and given a relatively stable world environment, they will be competing very hard for the business available from the corrugated pipe producers. The outcome of the dismantling of Canada's National Energy Program raises further questions for all plastic users, including drainage tubing producers.

Given this scenario: Healthy competition and good supply, the benefits of availability and quality will come through to both the contractor and end user. Quality and price are more closely intermingled than may appear at first glance.

**Polymer grades –**
**Virgin resins**

Virgin resin is material which has not been processed by any heat producing process after leaving the polymerization plant. These resins fall into several quality categories.

Prime material has closely monitored physical properties produced with specific properties to suit specific end use applications.

Utility material is material produced for specific applications, but with wider tolerances for the physical properties.

Off grade resins are virgin resins that have not met a specific property and consequently are considered to be

not suitable for the application intended. They could be off grade due to color, gel content, melt index, density, lack of stabilizers or any combination of these defects.

**Reprocessed material**

Thermoplastic resins are materials, which lend themselves readily to recycling. With the steady increase in resin costs, there has been a rapid growth in this area. Plant waste from the polymerization plants (plant waste could well be prime resin that has spilled, or material washed from a hopper car or truck or true waste) is blended with reground from products such as film, bottles, or injection molded parts, then extruded and palletized to produce a homogenous material with a melt index and density suitable for a specific application.

**Reground**

Some products produce reject items that cannot be reground and fed back into the production system. A good example of this is a bottle plant that prints on natural or white bottles. Up until printing, the reject bottle can be reground and fed back to be blended with virgin resin for production. Once printed however, the rejected bottle becomes suitable only for dark colors, and consequently the reground is accumulated and sold.

**Scrap parts**

In 1983 pipe extruders actively purchased scrap plastic products and reground them for blending into pipe compound. Since the product does not carry dangerous products, nor does it have to be cosmetically perfect, it lends itself to the incorporation of any or all of the four types of resin mentioned.

Depending entirely on percentages and quality of feed stock, the quality and uniformity of the pipe will be affected. The variations are endless and far too complex to cover completely.

The ideal resin has a melt index below one and a density above 950 but below 960. A good place to start would be with a solid foundation – 40 percent prime virgin, add in 20 percent utility and 20 percent of off-spec. This leaves 20 percent still to fill in. (For this imaginary mixture conveniently forget that some color concentrate should be added).

Which of the other three options should be chosen as the filler? Repro material from a reliable source would be a good choice. The properly designed compounding extruder of a reprocessor will give a far better mix of the various compounds than the production oriented screw in a corrugator's extruder. Reground for any one of the portions could be substituted.

As you get further away from virgin resin, it not only gets less expensive, the risk of receiving material that is not suitable for corrugated pipe is increased.

Injection molding HDPE has, in many cases, a density between 950 and 960, but its higher melt index makes it prone to stress crack. Unfortunately, when reground, it looks exactly the same as blow molding regrind. In small quantities, properly compounded, the effects could be minimized. What is the minimum level? Once a producer begins to use materials of unknown origin, the potential for problems increases. Unfortunately, the level of potential problems is well disguised and beyond the scope of most pipe producers to evaluate.

Under enough market pressure the choices become increasingly cost oriented and the risk of unsuitable product increases. The sheer volume of material consumed by the corrugated pipe industry puts a tremendous strain on the limited availability of uniform feed stock for either the reprocessors or for direct sale to the extruders, thus leading to wider range blends.

For instance, a large quantity of 5.0 melt with a little 0.03 melt material, blended in the right proportions, will give a 0.6/0.955 melt index/density, but it will be more prone to stress crack than a virgin 0.6/0.955 resin.

The prices of the various resin qualities vary enormously, especially between Canada and the US. However, a resin buyer can juggle the percentages and the costs to come up with an economical material from which to produce tubing. The critical thing is to ensure quality of tubing.

Naturally the first reaction is that all pipe should be run from nothing but prime virgin resin; this will guarantee the quality, and relieve everyone of many of their problems. However, there will be cries of "No one will buy at this price" or "I can't compete with clay tile anymore".

The further down the price is driven, the further down the scale of resin the extruder must go to remain competitive and profitable. There is a happy medium that can be achieved if everyone communicates effectively and makes sure that when comparisons of finished pipe are made one is comparing apples with apples.

The choices are many; some of them can be very strongly influenced by contractors who are very often the direct link with the ultimate purchaser. Contractors' opinions and experience are valuable. Used wisely they can become a powerful force in bringing about an upgrading in the quality of pipe that is produced, but only if the purchaser fully understands that he really will get only what he pays for.

Notes from talk by Sean Dennis, President of Inte-resins Ltd. of Mississauga, Ontario. Inte-resins Ltd. is a plastic resin broker supplying materials to the drainage pipe producers.