AddMix® P500 system

AddMix® P500 system is designed to manufacture medium voltage peroxide crosslinkable compounds employing the Alchemix™ Process. The system can be used to produce both natural and black peroxide crosslinkable compounds using suitable LDPE and proprietary additives supplied by Alchemix. Proprietary additives include liquid stabilizers mix and optional black masterbatches for black XLPE compounds.

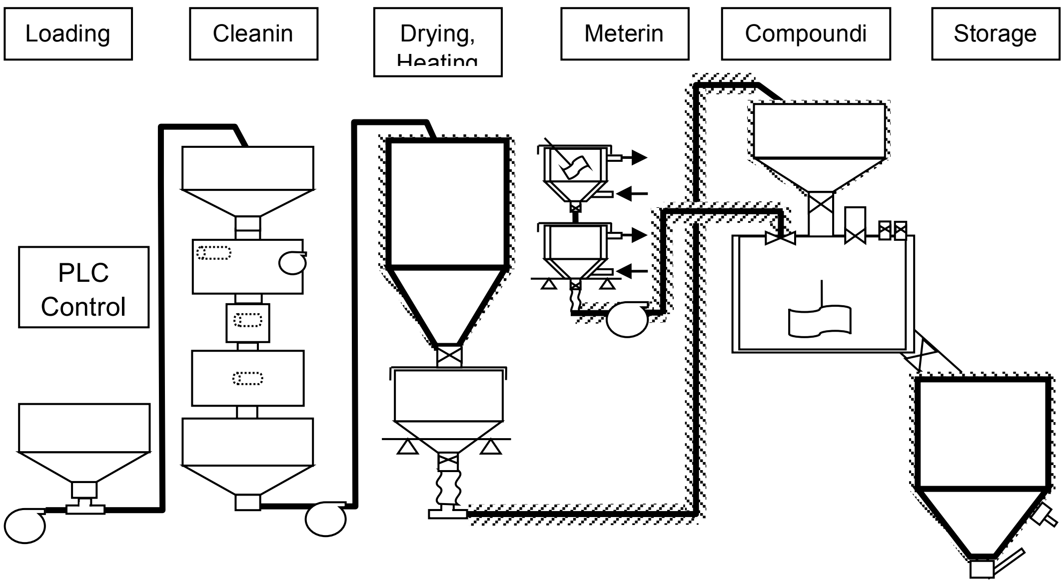
Many major cable producers developed self compounding processes thereby empowering them to manufacture in-house compounds. This process technology had been up graded and refined by Alchemix, using the state of the art equipment and techniques and is now available to cable and compound manufactures to produce quality compounds for own consumption or for resale.

AddMix® P500 system offers users an easy-to-operate, reliable and affordable system to produce quality crosslinkable compounds. The complete working system includes a fully integrated compounding line with platforms, supporting structures and training / consultancy in material handling, processing technology and quality testing of the finished compounds.

AddMix® P500 system includes the integrated de-dusted, de-streamed and de-metalized unit to remove contaminants from the base resin. The final compound is ready for extrusion, after 24 hrs of storage time, in C.V. lines operating at normal processing conditions.

The Addmix® P500 system will allow the end-user to manufacture both natural and black compounds using the same set of equipment.

A standard AddMix® P500 system has a production rate of 500 – 600 kg/hr. Customization for other production capacity is also available.



Key features and benefits of AddMix® P500 system

The key advantages of AddMix® P500 system are as follows;

Cheaper compound cost : Typical cost savings of USD 150-200 per MT could be realized. For an average cable manufacturer this translates to saving of about USD15,000 per month or USD180,000 per year.

Control on raw material purchases : Significant savings can be realized in purchasing freely available commodity type PE, instead of a specialty type compound from specialized compounders.

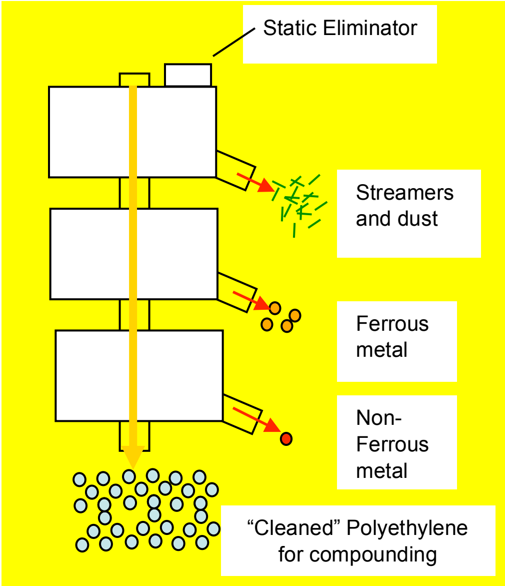
Ease of operation : The technology utilizes a batch process that can make up to 500-600 kg/hr. The process can be stopped and started anytime without significant wastage (typical wastage levels are between 0.2-0.3 %) and high start up cost.

"Fresh" compounds : On site production 2-3 days before consumption, would eliminate problems such as "blooming" and "lumping", usually associated with the storage and transportation of peroxide compounds through extreme conditions. The stabilizer and peroxide remains well dispersed within the pellets which would result in reduced stickiness and better handling of the finished compound.

Flexibility in production volumes : The production volume can be tailored to each company's individual preference, with the possibility of significantly increasing production without the corresponding need of acquiring any major equipment.

Flexibility in tailoring specific compounds : Companies can formulate different compounds to meet specific requirements. This includes black peroxide compounds which are usually more difficult and expensive to purchase

Integrated cleaning tower : AddMix® P500 system comes with a cleaning system to remove undesirable materials such as streamers, dust, ferrous and non-ferrous metals contaminants from the incoming polyethylene. This results in superior compounded products. (see figure).



Multi-stage cleaning of polyethylene by AddMix® system for best product quality

Easy to operate and maintenance: AddMix® P500 system is designed for easy operations, maintenance and cleaning.

Integrated PLC control for high productivity and less error : AddMix® P500 system is designed with the end users' production operators in mind. Human error is minimized by specially designed integrated checking systems to ensure a trouble free production process.

General description of process

The process consists of micro-dispersing the predetermined amount of peroxide, stabilizer and other chemicals into a LDPE pellet and the impregnation of these chemicals into the pellets. The chemicals, which are in the liquid phase, are absorbed into the PE pellet through a diffusion process, until the pellets are completely impregnated. Homogeneity is assured because absorption takes place in the liquid phase. This is an important and significant difference between the Alchemix™ Process and some other systems as the dispersion and homogeneity of the key ingredients are done in the liquid phase. Compounding is done in a modified compounder, warmed to a temperature that promotes rapid adsorption of the peroxide and other additives into the PE pellet.

The incoming PE pellets passes through an ionized separator which removes all fines and streamers. Removal of the streamers and fines results in an even distribution of crosslinking chemicals that lead to a compound with a lower scorching potential. The pellets are further treated by passing, through a magnetic separator which removes ferrous metal particles and than through another metal separator to remove all remaining metallic containments.

The pellets are discharged into the compounder where the rotor speed is controlled to ensure the micro- dispersion of the ingredients. Too fast a rotor speed results is shearing of the pellets (creating the undesirable streamers) and a corresponding build up of heat that might induce pre-crosslinking. Too slow a rotor speed will result in the inhomogeneous absorption of peroxide that will result in pre-crosslinking (in areas where there is an overabundance of peroxide) or under-crosslinking (in areas where there is too little peroxide) during extrusion and curing.

The amount of PE compounded for each batch depends on the size of the reactor. Micro dispersion depends, among other things, on the ability of different pellets to come in contact with chemicals, at the onset of adsorption. A limited size reactor will restrict the movement of pellets which in turn limits the contact time between uncoated pellets and the chemicals. The result of this restricted movement is that some pellets would have a higher level of chemicals associated with it.

Another important consideration is the time of compounding. The time for compounding is predetermined and controlled to ensure that the resulting pellets are dry and free flowing, contain the desired chemical ratio homogenously distributed throughout each pellet. An insufficient compounding time will result in the poor and uneven distribution of chemicals within each pellet. On the other hand, over compounding may result in overheating of the pellets which may lead to pre-crosslinking during compounding.

The resulting compound is discharged into a PE lined insulated container and is left to stand for several days. The chemicals will, within that time, establish equilibrium between the adsorbed and exudate phase. Each compounding cycle is about 10 minutes long.

Active Ingredients

PE Type : As the LDPE to be crosslinked constitute the bulk of the raw materials consumed, the finished properties of the insulation are greatly influenced by the selection of the polymer type. Issues on processibility, melt temperature, consistency and cleanliness of the base polymer are important properties that determining the overall performance of the cable.

Contamination severely restricts the suitability of a particular LDPE that can be used for cable insulation. LDPE is manufactured using a catalyst free high pressure reactor which results in polymer that is generally free of contamination. Contamination is introduced in the pelletization stage with the addition of additives such as slip, anti block chemicals and other stabilization chemicals. In addition, surface imperfections on the transportation tubes and the bulk storage tanks may give rise to imbedded metallic contaminants in the pellets. Other sources include airborne contaminants and degraded polymer. Many commodity grade LDPE manufactures do not have suitable precautions in place to maintain a contamination free environment. However, a LDPE manufacture could be persuaded to take certain simple measures which could result in a polymer that would be suitable for voltages up to 33 KV.

A suitable LDPE should have a MFI of between 0.7 – 2.5 g/10 min., a density of between 0.918 and 0.922 g/cc and a melting temperature of below 125 ^{o}C.

The selected LDPE should undergo a cleaning process via an extrusion in suitably sized screens.

A list of qualified LDPE grades will be given by the representative.

Peroxide Type : The process of crosslinking is initiated by the action of heat on the organic peroxide. The selected peroxide is stable over the "safe" processing temperature (120-130^{o}C) so that scorching within the extruder is minimized. The dissociation of the peroxide is completed by the first third of the curing tube, so as to ensure sufficient residence time is provided for the solidification of the cable before exiting the curing tube.

The adsorption of peroxides into polymers, in particular LDPE, has been practiced for over 40 years and the rates of adsorption of some of the common peroxides in LDPE are well documented. Among the more important parameters, adsorption rates depend upon the solubility of the peroxide in PE, the temperature and distribution temperature within the PE, the surface area in contact with the peroxide (the size and size distribution of the pellet) and the compounding parameters. The homogeneity of dispersion within each pellet and among all the other pellets, will directly impact on the crosslinking quality. The process technology described herein, allows for the rapid adsorption and proper distribution of infused peroxide within each and among all the LDPE pellets.

It is important that the equilibrium between the adsorption and exudation rate of the infused peroxide be established so that the desired amount of peroxide remains well homogenized in the LDPE pellet during storage. It is equally important that the amount of active peroxide be constant over a range of ambient pellet temperature ranges so that the performance of the compound is consistent over normal storage conditions. Such factors as liquefaction and volatility temperature of the selected peroxide and the infusion temperature during compounding are important parameters that ensure the performance of the compound will not vary from batch to batch.

Antioxidant Type : Virtually all polymeric materials will undergo oxidation reactions during the service life and especially during extrusion. This deterioration manifests itself in physical changes and reduced mechanical properties such as elongation, tensile strength and flexibility. Antioxidants protect the polymer against oxidation by controlling molecular weight changes that leads to a loss of physical and mechanical properties.

The overall effectiveness of the antioxidant also depends on the homogenous incorporation of these chemicals in the PE pellet such that the possibility of pure antioxidant inclusions is avoided. These antioxidant inclusions, usually in the crystalline state, present in the final insulation will ultimately lead to premature breakdown failures. Antioxidants are prone to exudation from the compounded pellets that results in a disproportionate concentration of antioxidant in various parts of the pellets.

This in turn affects the degree of crosslinking and the aging characteristics along various sections of the finished cable. Using a low shear extruder and a processing temperature profile between 110-130° C, will leave the crystalline antioxidant intact during extrusion, hence enhancing the possibility of insulation breakdown. An exudation resistant antioxidant will reduce the blooming tendency (the formation of pointed shaped crystals).

The liquid antioxidant provided by Alchemix™ greatly improves the miscibility of the stabilizer into the PE pellets. The liquid stabilizer is filterable, enhancing its cleanliness and hence its desirability.

Components: The process requires essentially three components, with the bulk being LDPE and peroxide,purchased directly from approved manufacturers and about 0.5% of a liquid antioxidant mix purchased from Alchemix™.

Processibility of compound

General

The product manufactured by this compounding procedure and using the prescribed LDPE, provides excellent surface

and high output rates over a broad range of extrusion parameters.

Extruder

Use a standard PE extruder with a cooling screw.

Screw diameter : 20-150 mm

Length of screw : 20-25 D

Screw design : Barrier type or equivalent having the last 2 D as a Maddox mixing zone to achieve thermal mixing and homogenization of the melt.

Screen packs : with 4-5 screens 1/0.5/0.3/0.2*/0.5

(* Optional)

Extruder Temperature/Melt Pressure Profile

Barrel	Z1	Z2	Z3	Z 4
Temperature °C	105	110	115	125 (+/- 4)

Screw Temperature 100 (+/- 10° C)

Hopper Temperature 50 (+/- 5° C)

NOTE: It is important to keep the melt temperature in the extruder under 135° C to avoid scorching.

Depending on the cable type, line speeds, and outputs different melt pressures can be realized. Usual values for the melt pressure are;

180 Bar (11 KV, 12 m/min.)

260 Bar (25 KV, 10 m/min.)

CV Tube Temperature/Pressure Profile (dry curing)

For 20 KV cables, the following profiles are recommended;

Line speed 10-15 m/min.

Tube	Z1	Z2	Z3	Z 4	Z5	Z6
Temperature °C	360	380	400	390	380	370 (+/- 30)

Nitrogen Pressure 8-10 bars

NOTE : the information and data contained herein serves only as a guide. No liability, warranty or guarantee of the product is created by this document. It is the user's responsibility to ascertain the appropriate operating conditions based on the user's own equipment and experiences.