TURN-KEY
MANUFACTURING PLANT
for
GRP PIPE
CONTINUOUS FILAMENT WINDING
300-2600mm

~ PRELIMINARY OFFER ~

CONTENTS

1 GENERAL ON CONTINUOUS GLASS REINFORCED POLYESTER PIPE PRODUCTION

The present proposal covers the implementation of a new factory for the manufacture of glass reinforced plastic (G.R.P.) pipes through the establishment of :

- **Continuous line for the continuous production of pipes with diameters from 300 to 2600**

The project covers the installation of the production facilities relevant to the manufacture of pipes with diameters ranging from 300 up to 2600 mm with a maximum output corresponding to 220 km/year of 600 mm based on three production shifts/day for 330 working days/year.

2 G.R.P. PRODUCT CHARACTERISTICS

2.1 GRP Pipes Wall Description

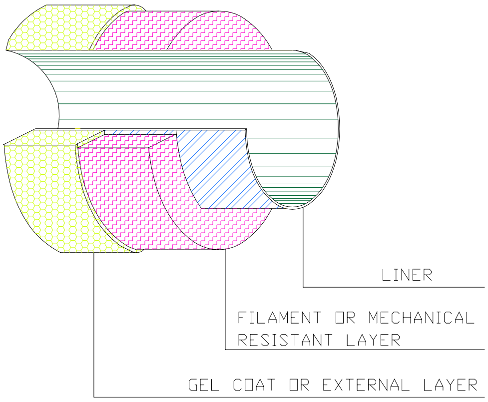
The G.R.P. pipe wall consists of three layers perfectly adherent with one another, each having different characteristics and properties in relation to their function. The properties of chemical resistance and impermeability are, anyway, equivalent for the three layers which are namely:

- liner:

  It is in direct contact with the conveyed fluid and guarantees the maximum resistance to the chemical attack from the fluid itself. Moreover, the liner presents an internal surface particularly smooth, without defects, cracks or delaminated zones. The liner is composed of one glass veil and one glass mat tape resin impregnated and is produced in two steps (inner liner and outer one)

- filament or mechanical resistant layer:

  Its function is to render the pipe wall resistant to the stresses due to the design conditions (stresses due to the internal and/or external pressure, flexural strength due to the external loads etc.) and generated by transport and laying operations. The thickness of the filament depend, then, upon the design conditions. The mechanical layer is composed of winded glass filament roving chopped glass, sand aggregate, glass mat reinforcement, all polyester resin impregnated.



- gel coat or external layer:

  It has a thickness of about 0.2 mm and consist of pure resin without glass reinforcement. It guarantees the complete impregnation of the peripheral fibers, thus yielding the external pipe surface completely free of protruding fibers and well finished. The external coating is always added with ultraviolet rays inhibitor in order to prevent the nearly negligible weathering effects.

2.2 End Couplings

The pipe coupling is made by a GRP sleeve with continuous elastomeric gaskets with double or triple lips.

2.3 Fittings

A wide range of fittings and special pieces can be manufactured in G.R.P. They present, therefore, the same characteristics, both chemical and mechanical, of the pipes. Fittings are manufactured manually employing male moulds or pipes pieces to be joined together. Ends of fittings can be bell and spigot type provided with sealing gaskets or plain type to be joined by welding to adjacent pipes or other fittings. The normal production of the new factory includes:

- 90° or 45° bends (by moulds)
- concentric and eccentric reducers (by moulds)
- fixed flanges and stub end (by moulds)

- blind flanges (by moulds)

Moreover, other special pieces such as manholes, flanged pipes equal and reduced tees etc. can be manufactured by welding together fittings and/or pipes sections.

2.4 Advantages In G.R.P. Application

Glass reinforced plastic pipes represent the ideal solution for the adduction of any kind of water, chemicals, effluent and sewers, because they combine the advantage of corrosion resistance, typical of plastics, with a mechanical strength which can be compared with the steel one. Typical properties that result in advantages in G.R.P. pipes application, can be summarized as follows:

- Low weight of pipes lengths that allows for the use of light laying and transport means.
- Possibility of nesting of different diameters of pipe thus allowing additional saving in transport operations.
- Length of sections larger than other materials ones.
- Easy installation procedures due to the kind of mechanical bell and spigot joint.
- Corrosion resistance, both of the external wall in contact with the conveyed fluid. No protections such as coating, painting or cathodic are then necessary.
- Smoothness of the internal wall that minimizes the head losses and avoids the formation of deposits.
- High mechanical resistance due to the glass reinforcement.
- Absolute impermeability of pipes and joints both from external to internal and vice-versa.
- Very long life of the material virtually infinite, which does not need maintaining.
- Workability of the material in site employing simple equipment.

2.5 Inspection and testing

Before starting up production a check is made on the quality and characteristics of the resins relatively to the temperature and relative humidity in the production shops.

Optimum values of viscosity and temperature to be applied to the resin are pre-established, and the percentage of catalyst to be employed in the production phase is determined.

Controls in the production shops:

- control of lay-up (unit weight per square meter of resin and glass, type of resin and type of reinforcement)
- internal quality control

- check on the type of glass reinforcement used
- dimensional control of the positioning of the accessories according to technical specifications
- check on thickness
- check on post-polymerization treatment (on continuous pipes). Continuous pipes manufactured are put into an oven having forced circulation of hot air and undergo heat treatment there. The purpose of this treatment is to complete the cross-linking of the resinous matrix. The degree of polymerization is directly related to the percentage of residual styrene monomer, which is established by laboratory analysis.
- chemical tests: The quantity of styrol in the solution is deduced by comparing its peak with the peak of precisely known quantity toluene. A maximum of naught point two percent of free monomer is accepted (naught point five percent is permissible by law).

- Checking the weights: As it is withdrawn from the post-polymerization oven the product is weighed to ascertain the difference between the real weight and the weight foreseen in the theoretical construction sheets.

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- Checking the Barcol hardness: Measurement of the hardness gives an indication of the degree of polymerization. This test is carried out on fifty percent of the products made.

3 RAW MATERIALS

The raw materials employed for the manufacturing of pipes are mainly polyester resins and glass reinforcements in the form of veils, chopped strands, woven roving and continuous filaments.

3.1 Resins

The polyester resins belong to the group of alkyd resins and present themselves in the form of colorless or slightly amber viscous liquids. In the commercially available state, the resin composition is represented by long linear chain, obtained by esterification of dicarboxyl acids with glycols and then dissolved in one or more saturated liquids monomers. One of the basic characteristics of polyester resin, is the presence of unsaturated bonds arising from the use of maleic anydride or other unsaturated components during the esterification. During pipes or tanks manufacturing, the resin hardens due to the polymerization reactions between the unsaturated radicals contained in the polyester chain. The resin then becomes a cross linked structure and assumes all the characteristics of thermosetting products such as, for example, the condensate of phenol, melamine or urea with formaldehyde. Polymerization reactions and hardening of resins, is promoted by special catalyst systems which are able to act even without the presence of high temperatures or pressure. The pipes and tanks production is in fact carried out at ambient temperature and atmospheric pressure. The mentioned cross linked bond can be represented by the following scheme:

```
A.B.A.B.A.B.A.B.
   .        .
   C        C
   .        .
A.B.A.B.A.B.A.B.
   .
  C
   .
A.B.A.B.A.B.A.B.
```

where:

A represents a polyoxydryl alcohol .

B represents an unsaturated acid

C represents an unsaturated product such as styrol

By varying the nature of the components of the resin (that is, by using glycols of different types and acids with a higher or lower weight) it is possible to obtain resins having different mechanical, thermal or chemical properties. The most employed resin in pipes manufacturing are the following:

- Polyester resins based on bisphenol or bisphenol A in a solution of styrol monomer.

  Viscosity = 3.5 - 4 poises.

  Reactivity = medium.

  This type of resin provides good chemical inertness coupled to high mechanical strength in the laminate.

- Polyester resins based on isopthalic acid in a solution of styrol monomer.

  Viscosity = 4 - 5 poises.

  reactivity = medium to high.

  This kind of resin assures good mechanical strength to the laminate and is the best solution, both under the point of view of economics, reliability and resistance for manufacturing goods to be used to transport any kind of water.

- Vinylester resins in a solution of styrol monomer.

  This resin is employed when hot high corrosive products have to be handled and conveyed.

  All the employed resins are, in any case, thermosetting type that means that the shape of the products, assumed after the polymerization, is not affected by heating and then high stability at temperature is assured. The same or different resins, if compatible, can be employed to manufacture the various layers of pipes.

3.2 Glass Reinforcements

Glass fibers are produced in the form of continuous filament, as per the following briefly described process. Various components are mixed together in order to obtain a basic compound characterized by a definite composition. The compound is then sent to a furnace, where is melted at high temperature so as to produce glass. The molten glass is then drawn into precision size controlled thin filaments. Filaments are successively processed into roving, mat, yarn or cut strands that are the basic reinforcements for the thermosetting resins. Glass necessary to produce pipes are the following:

- "C" glass tape.

  It is in the form of veil with continuously and uniformly distributed fibers over the whole surface and with a porosity and stiffness such as to enable handling in the cutting and applying operations.

The veil is packed in rolls and presents itself as a tape 25 cm width with a specific weight of 30-35 g/m2.

The main characteristics of the veil is the high chemical resistance and is, in fact, employed to manufacture the first layer of the liner of pipes (inner liner).

- "E" glass chopped strand mat tapes.

  It consists of chopped glass fibers not woven. The chopped fibers are distributed without any preferential orientation but in order to assure a regular specific weight to the tape.

  The fibers are bonded together with a polyester base binder. The mat tapes, packed in rolls, present a width of 25 cm and a specific weight of 375 or 450 g/m2 and are employed in the manufacturing of the second layer of the liner of pipes and tanks (outer liner).

- "E" glass filament roving.

  It consists of strand of continuous glass filament roving supplied in rolls. More parallel strands are employed to manufacture the mechanical resistant layer of pipes. Density or size of roving is defined in grams per kilometer of single filament (tex = 2400 or 4800).

  Filaments are sized with a special sylan finish that imparts a taping effect to improve the efficiency in winding operations.

- "E" glass woven roving tapes.

  It is a tissue made of strands of continuous filament roving oriented in the two main directions.

  They are treated with binders in order to impart excellent adaptability to the shape of the moulds without any wrinkling, empty spaces or irregular dripping of the resin to be applied.

The woven roving tapes are employed to manufacture the mechanical resistant layers of hand made fittings.

3.3 Auxiliary Raw Materials

The auxiliary raw materials are necessary, in limited quantities, to promote or inhibit the polymerization reactions in order to better control and select the working phases both for pipes. Ultraviolet rays inhibitor agents are employed to increase the already great resistance to weathering.

The main auxiliary raw materials are namely:

- Catalyst for polyester resins: 50% solution of methyl ethyl ketone peroxide in dimethylphtalate.
- Accelerator : solution of cobalt naphtenate in styrene.
- Inhibitor : 10% solution of ter-butyl-catechol in styrene.
- Thixotropic agent : micronized silica gel.
- Solution of paraffin in styrene.
- Polyvinyl alcohol.
- U. V. rays inhibitor.
- Silica sand

4 FACTORY DESCRIPTION

4.1 Production Capacity

Range of producible pipes and factory capacity, are sized in order to satisfy the local needs of potable water lines and networks, irrigation and sewer systems.

The proposed factory is sized for an average manufacturing capacity of 12000 ton/year of finished fiberglass pipes with average diameters of 300 - 2600 mm, based on 3 shifts of 8 working hours each shift, and on 220 working days/year, with a mix of dia. 600, 1000 and 1600 mm. production.

4.2 Factory Layout And Installations

4.2.1 Total Extension

The factory should cover a rectangular shape plane area of about 30.000 m2, of which 2000 m2 covered area.

4.2.2 Manufacturing Unit Building

The manufacturing unit consists of a steel or reinforced concrete structure shed of rectangular shape plan and is divided into a process area and service zones.

The shed of the process area is sustained by two rows of columns providing 5 m height at crane hook and is completed with curtain walls made of masonry and transparent material.

The floor is made of leveled concrete 20 cm thick, reinforced with steel net and finished at surface with one cm of quartz paving.

The shed covers the following installations:

- Process area for pipes:

  process area for pipes including bell coupling

  one overhead travelling crane (5 tons capacity)

  fittings manufacturing area

- Services areas:

  resin mixing room

  glass storage area

  warehouse (shelves, welding and drilling machine, grinders and tools, spare parts).

  quality control laboratory.

  dressing rooms, showers and toilets.

  pressure test equipment for pipes (if foreseen).

4.2.3 Sand Store And Feeding System

Sand storage silos should have at least 150 ton capacity. The sand is transferred to the filament winding machine sand distributor by means of a screw feeder.

4.2.4 "E" And "C" Glass Fiber Distribution System

The fiberglass coils are assembled on steel frames and the fiber threads are fed to the filament winding machine through ring guides and tensioning device.

4.2.5 *Resin feeding and mixing system*

Resins are stored in suitable underground tanks (120 ton capacity at least) and are conveyed to the daily feeding tank by means of poliethylene pipes.

There, resins are added with Cobalt Naphtenate and mixed by means of electric blade stirrers, driven by the control panel of the continuous F.W. machine, with continuous electronic control of the operation in respect of temperature and flow of various components.

By means of suitable dosing pumps, resin are then pumped and conveyed to mixers where they are further added with organic peroxide and then, by free-fall, used in the production process.

4.2.6 *Utilities And Ancillary Installations*

The manufacturing shed should be completed with the following utilities and ancillary installations:

- fire fighting network, hydrants and hose reel boxes.
- wall mounted powder or CO_2 extinguishers.
- fire fighting diesel pump (one unit).
- fire fighting electric jockey pump (one unit).
- concrete raw water reservoir.
- potable water network.
- raw water pump (one unit).
- raw water network.
- sewer network.
- shed venting systems.
- glass powder suction system.
- hydraulic test equipment facilities.
- Two frontal fork lift 3 ton capacity and one side fork lift 10 ton.
- fence and gates.

The positioning of the utilities equipment is shown on drawing attached herein. Brief description of some utilities is given here below:

- concrete reservoir:

  The concrete reservoir contains the water necessary for the fire fighting system and raw water consumption. Water to the reservoir is fed by means of a 2" pipe sectioned, at factory battery limits, by locked open gate valve installed in pit.

The capacity of the reservoir is about 110 m3 whose 10 m3 are relevant to the raw water consumption, while 100 m3 are assured to the fire fighting system in order to allow for one hour autonomy.

- fire fighting system:

  The fire fighting station is composed of one diesel engine operated pump and an electric motor jockey one. The diesel engine is provided with its own fuel daily tanks.

  Foreseen head and flow rate of the diesel engine pump are respectively 100 m.c.l. and 100 m3/h, considering the future phase. The jockey pump continuously pressurizes the 8" network, at head and rate of 60 m.c.l. and 10 m3/hr respectively.

  When pressure in the fire fighting network reduces below 3 bar, the diesel pump automatically starts and will be stopped by manual operations. Hydrants are distributed along the 8" fire fighting ring, each provided with two hose connections.

  The hoses are contained in boxes located nearby the hydrants.

- compressed air system:

  Envisaged flow rate is 5,000 l/min. at 7 bar. Compressed air piping, inside the shed, is composed of 2" pipes rings running on steel structures and provided with 1" shed crossing pipes, installed inside the ducts and wall mounted connections.

- potable water:

  The potable water is fed by a 2" pipe, sectioned at factory battery limit by a gate valve installed in pit and is directly conveyed in the factory network.

  Potable water feeds the office building area, the toilets of the shed and the test and laboratory rooms.

4.2.7 Electric Installations

The total electrical power installed is 400 KVA and considering a contemporaneity of 75% the required power is 300 KVA about.

The main electric installations inside the fence of the factory are then the following:

- general electric switch board and control panels.

- power sockets (32 A).
- lighting system inside and outside the shed.
- earthing system.

The diesel generator is located under an own steel shelter and is completed with its own daily tank. Lighting inside the shell is realized by means of roof mounted mercury vapors lamps, 250 W each. Every six meters of shed, two lamps are foreseen.

4.2.8 Service Buildings

The following building are envisaged to be installed inside the factory area:

- one prefabricated or masonry building suitable for the accommodation of 10 employees and one manager. The building is provided with office furniture and toilet.
- one prefabricated building for resin drums depository (20 x 8 m)
- two block houses (2,5 x 2,5 m each) for storage of catalyst

Moreover, a cover for vehicles is foreseen (40 x 5,5 m).

4.2.9 Open Spaces

Not covered spaces extend for about 41.000 m2 and are partially asphalted or otherwise treated for storage of finished products, internal roads and open air tests.

The factory area is fenced and provided with one main and two services gates.

5 PIPE MANUFACTURING PROCESS DESCRIPTION

The manufacturing process is based on the filament winding technique and complies with A.S.T.M. code D 2996 (Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipes) type 1, grade 2, class E and ASTM D3517, ASTM D3754, ASTM 3262, BS 5480:1990, AWWA C950, AWWA Manual M45

The manufacturing process proceeds step by step as follows:

5.1 Continuous Pipe Technological Process Description

The continuous production of GRP pipes through the filament winding process, avails itself of a mandrel which surface is made of a steel tape moving longitudinally with a speed depending on the tape width.

The band is elycoidally wound on suitable supporting bearing placed along the mandrel.

A defined number of pushers, driven by a suitably shaped cam plate, moves the steel band longitudinally.

A special mylar release film, protecting the surface of the mould and useful during extraction operations, is applied to the mandrel. Then, a ply of chemical resistant "C" glass is laid up the mandrel. This glass reinforcement, suitably impregnated with liquid resin, will be the chemical-resistant inner liner of the pipe, being rich in resin (90% resin, 10% glass) and having a predetermined thickness.

The final layer (external liner) will have the same characteristics as first.

Two other layers are applied between the first and the last ones:

a - an anti-diffusion barrier made of 70% of resin and 30% of chopped glass (second liner) b - a mechanical resistant layer which thickness, composition and glass yarns disposal depend on the mechanical characteristics required for the pipe

These internal layers consists of the following raw materials:

- resin
- chopped glass yarns
- continuous glass yarns (roving)
- silica inerts, if needed.

The continuous roving, circumferentially wound, assures the required circumferential resistance, while the function of the chopped glass (chopped glass yarns 25-30 mm length randomly applied) is to grant, through the axial resistance contribution of each glass yarn, the required axial resistance.

The silica inert, when applied, increases the stiffness characteristics and the pipe wall thickness, without exceeding the quantity of glass foreseen.

The chopped roving is laid on the pipe surface through the slit of a hopper placed upon the mandrel. The glass yarns conveyed from the feeding units are then chopped using a suitable cutter. The required quantity of chopped glass applied to the pipe wall will be achieved by combining the cutter rotating speed (quantity of chopped glass produced) with the mandrel surface translating speed (being finally the rotating speed of the mandrel).

The continuous glass yarns, supplied by the feeding units, are hoop-wound on the manufacturing pipe by driving the roving through some tensioning devices, thread guides and distributing rack. The required quantity of continuous roving can be obtained by defining the suitable number and substance of yarns, while disposal of yarns in the different pipe section layers can be suitably arranged by modifying the position of the yarns in the thread guides and in the distribution rack.

The silica inert, if required, is applied through the slit of a hopper placed upon the mandrel and is batted by modifying the rotating speed of a knurled cylinder placed peripherally to the hopper.

The resin is supplied and applied to the mandrel surface by means of two special feeders equipped with suitable gauged holes. One of the feeders supplies the resin required for the manufacturing of the chemical resistant inner liner and anti-diffusion barrier. The other has the function of supplying the resin for the mechanical resistant layer and external liner. The adoption of two feeders for the manufacturing of the different layers allows using two resins for the same pipe bar.

The feeders contain resin which is already mixed with catalyst in the due proportion. Mixing operations are carried out in two different mixers, one for each feeder. Resin and catalyst are delivered separately to the mixers by means of batching pumps. The quantity of resin and catalyst required, as for other raw materials, depends on the mandrel speed and is defined through a suitable electronic batching system.

Polymerization of the resin (hardening of the product) is carried out in an oven with 4 differentiated areas with radiant heating units. For each area the heat to be supplied can be controlled so that the assure the maintaining of the required values of gelification, isothermal peak and post-polymerization in the oven.

The production line is equipped with gauging and automatic cutting device.

The pipe cutting at the required length is made by means of a diamond disc tool following the progress of the product.

After cutting, the pipe bar is automatically moved away through three lifting tables

Whenever required, pipes manufactured are subjected to an hydraulic pressure test: each pipe bar is filled with water and then, by means of a suitable press, its internal pressure is increased up to 1.5 or 2 times more than the nominal pressure the pipe should withstand. The press structure is able to withstand a max. axial thrust of 1000 ton.

Moreover, all pipes produced are subjected to a careful quality control by means of systematic non-destructive tests as:

- thickness measurement
- Barcol hardness measurement
- visual examination

In addition to the above, some samples are subjected to the following destructive tests:

- parallel plate press test
- burst test
- fire resistance test
- axial tensile stress test

- axial and circumferential bending test.

Both destructive and non destructive tests are carried out according to ASTM (American Society for Testing and Materials) standards.

The quality control on the final product is preceded by a careful production process and raw materials control. For example, with respect to resin, controls are made on viscosity, reactivity, styrene content, elongation to rupture. With respect to silica inerts, granulometry, humidity content, silica and iron content are checked. For glass, controls are made on external aspect, humidity content, losses after calcining, roving stiffness, resistance to grinding.

5.2 Manufacturing production rate (mt/hr.)

Mandrel speed m/h						
Pressure (bar)	2,5-gravity pipes	4	6	10	16	20
ND mm 300	28	28	28	28	28	28
ND mm 400	28	28	28	28	28	28
ND mm 500	28	28	28	28	28	28
ND mm 600	28	28	28	28	28	28
ND mm 800	28	28	28	26	26	26
ND mm 1000	26	26	26	24	24	24
ND mm 1200	20	20	20	20	18	18
ND mm 1600	15	15	15	15	15	13
ND mm 1800	10	10	10	10	10	10
ND mm 2000	10	10	10	10	10	10
ND mm 2400	7	7	7	7		
ND mm 2600	5	5				

Production on 3 shifts x 220 working days

ND 600 mm 672 mt/day x 220 = 148 km (5175 ton)

ND 1000 mm 576 mt/day x 220 = 127 km (13,306 ton)

ND 1600 mm 360 mt/day x 220 = 79 km (18,800 ton)

Production mix

One third: ND 600 mm prod. 1725 ton

One third: ND 1000 mm prod. 4435 ton

One third: ND 1600 mm prod. 6260 ton

Average mix prod.12420 ton

6 PRODUCTION EQUIPMENT SUPPLIED

6.1 Continuous F.W. Machine

The manufacturing of continuous pipe is carried out by a continuous mandrel. This is formed by winding a continuous steel tape over an horizontal beam. The steel tape translates in the axial direction while the mandrel is rotating. The steel tape returns at the end of the beam and is driven into the mandrel inner empty section. It is then wound onto the opposite end of mandrel again. In this way the steel tape forms a smooth surface mandrel rotating with simultaneous advancing in the axial direction.

The laminate is applied onto the moving mandrel.

First a release film, e.g. polyester film, is wound on the mandrel, followed by a surfacing mat. Filament winding, together with chopped glass, sand aggregate and polyester resin are applied simultaneously. Finally a new layer of surfacing mat is applied.

According to the process philosophy, the layer applied next to the steel tape represents the chemical resistant inner layer, while the material supplied next to the curing ovens is the mechanical resistant outer layer. The laminate building-up can thus easily be made in compliance with the appropriate design by controlling the amount and position of various materials applied.

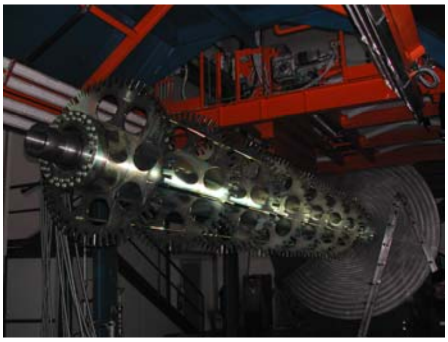
After the curing oven, the pipe is automatically cut to required length by a suitable sawing unit.

6.1.1 Mandrel

No moulds are required in the continuous pipe production process but only a mandrel which diameter can be modified according to requirements.

The main components of mandrel are:

- Steel tape
- Aluminium stripes
- Disc plate support
- Steel tape return device
- Main shaft (two sizes are supplied to cover ND 300-600 and 700-2600)
- Steel tape tensioning device



6.1.2 Resin dosing station .

The resin is supplied and applied to the mandrel surface by means of two special feeders equipped with suitable gauged holes. One feeder is foreseen for liner layer and other for mechanical structure layer. Such feeders contain resin which is already mixed with catalyst in the due proportion. Mixing operations are carried out in two different mixers, one for each feeder. Resin and catalyst are delivered separately to the mixers by means of double head dosing pumps. One pump is foreseen for liner resin and catalyst delivery , the other is foreseen for mechanical structure resin and catalyst delivery . The quantity of resin and catalyst required, depends on the mandrel speed and technological process .

The system includes:

- double head resin –catalyst pump for liner layer
- double head resin –catalyst pump for mechanical resistant layer
- No.2 dynamic mixing devices equipped with stirrers controlled by electric motors (one for liner and one for mechanical resistant layer)
- n.2 resin feeders (one for liner and one for mechanical resistant layer)
- complete piping ,valves , filters from dosing pumps up to the mixing devices
- safety valves , damphers
- non return valves

6.1.3 Polymerization Oven

The polymerization oven is placed on line with the advancing mandrel.

There are 9 longitudinal heating and reflecting sections placed over 18000 angle arc.

Each segment can be shifted radially in order to achieve the optimum distance between the heater and the pipe (250 mm).

Each segment is provided with 3 infra red heaters 2.1 kw each and 3 reflectors.

The infra-red radiation assures the uniform polymerization of the pipe.

From the electrical power supply the oven is divided in three areas along the axis. The heating units for each area have specific power 4,2 kw, 6,3 kw and 8,4 kw in order to give the most uniform heating flow for any pipe diameter.

The oven is equipped with suction hood for styrene emission and heat over flow system.

6.1.4 Process Parameters Control Device

- Sand feeding calibration and flow measurement and control device.
- Direct measurement of stroke/min on Bran-Luebbe pumps.
- Measurement of the flow of resin, accelerators and catalysts in lt. per minute.
- Remote control measurement of pipe surface temperature and location of peak exotherm position and temperature.
- Measurement of the laminate temperature during the wet to gel phase.
- Heating up the feeding resin to constant temperature or viscosity.
- Automatic tensioning devise and recording of the hoop roving.

6.1.5 Computer Control of F.W. Machine

The control and supervision of production cycle is made by computer connected to a PLC device controlling physical variable as material parameters (flow, temperature, tensioning etc.) and heat flow of oven and connected to a CNC device controlling the operation of filament winding machine.

It is possible to control the production process through the following parameters:

- flow of resin and catalyst
- temperature of resin
- level of resin stored
- control of temperature in the oven
- weight of pipe

6.1.6 Gauging, chamfering and cutting device

Gauging, chamfering and cutting operations are automatically made without any personnel requirement, by means of a tool holding trolley, placed out of polymerization oven, having the same longitudinal advancement speed of the pipe.

Such trolley is able to carry out these three operations at various positions, as selected by the control panel on the continuous F.W. machine.

Gauging is made by means of a grinder on a minimum pipe length of 300 mm. Purpose of this operation is to assure a constant external diameter of the pipe end and, in the meantime, to make the surface smooth.

Thanks to smoothness and diameter constancy the sleeve seal should be granted.

At the same time, by means of a second tool, chamfering of the central gauged area is made .

Then a diamond disk provides cutting of the pipe connected with chamfering.

6.1.7 Dust and Styrene suction system

Powders coming from gauging, chamfering and cutting operations are automatically sucked and conveyed to a particular device providing, thanks to a water dropping system, the falling of dust on the bottom end of the collecting tank. Daily, such wastes are taken away.

Styrene fumes produced in the polymerization oven are sucked and conveyed to a second suction device and emitted in the atmosphere.

These two suction methods grant that the values of fumes and dust emission concentration are within the limits fixed by law.

6.1.8 Pipe lifting and supporting planes

After curing and when exiting from the polymerization oven, the pipe is supported by three planes equipped with free-wheels ensuring rotation and advancement of the pipe itself.

The second plane is equipped with a special device rotating the pipe during cutting operation.

After cutting, the three planes simultaneously translate along pipe direction, dip down and place the finished pipe bar on two slating guides made of HEA steel profiles.

Then the pipe is moved to the suitable storage area by means of a lateral fork lift or similar.

6.1.9 Pipe antitorque supporting equipment

This equipment is of great importance for the production of heavy weight FRP pipes (large diameters and high stiffness).

The system consists of a double twin wheels acting as additional supporters of the pipe during its rotation and yelding a positive torque balancing the negative momentum caused by the pipe rolling friction.

The following materials are supplied:

- Rubber coated wheel for measuring of actual production
  speed with signal to control box,
- control box with microprocessor,
- hand wheel for diameter adjustment
- great motor for pipe rotation,
- turns potentiometer extra rotation.

6.2 Sleeve Coupling Manufacturing Machine

The sleeve couplings are made by resin impregnated E glass roving wound on a steel wheel mandrel over which a elastomeric gasket with double or triple lips has been placed.

These wheel mandrels are made of two half pairs: one half is assembled on a axle rotating by mean of motovariator and the other half assembled on a piston axle of a pneumatic cylinder.

As soon as the axle of the piston is backward it moves back half with mandrel and therefore the bell coupling can be extracted.

The bell coupling machine has two manufacturing positions to be operated at the same time and it is assembled as follows:

- two rotation axles assembled from both rider of a steel for supporting the motovariators, the transmission pear and the electrical switch board.
- two pneumatic cylinder devices giving the movements to the half mandrel wheel.
- one trolley for the resin impregnation of the glass roving.
- two heating groups for the polymerization of the GRP bell coupling product.

6.3 FRP pipe sleeve joint joining equipment

This machine allows the operators to join the FRP plain end section to the sleeve joint bell coupling.

The machine is equipped by one shifting end plate in order to operate for different FRP pipe section lenght and pipe diameter; it can be applied for length ranging from 2 mt up to 16 mt and for diameter ranging from 300 mm up to 2600 mm.

The equipment consists of the following main mechanical parts:

- shifting end plate
- fixed end plate
- two tie beams connecting the end plates
- two lifting tables to support the FRP pipe
- hydraulic operating apparatus.

Here below is reported a short description of the machine:

After the system has been settled according to the requested pipe length by shifting horizontally the shifting end table, the pipe is supported by the two lifting tables and positioned by adjusting vertically the pipe so as to move the centerline pipe to the end plates and sleeve joint center point.

When the FRP pipe and the sleeve joint are definitely positioned, the fixed end plate operates hydraulically in such a way to develop the thrust requested by the sleeve joint bell coupling friction during the joining stage.

6.4 Maintenance

Mechanical maintenance needed by the plant shall depend on the effective working hours and on the pipe diameters produced. Maintenance usually consists of: substitution of motovariator oil, bearings on the gauging grinding tool, diamond cutting disk, blades on chopping roller, oil on tables and tool holding trolley, mechanical sailing parts of dosing pumps, protecting rubber parts on sand roller.

It is required to make a weekly complete cleaning of dosing pump.

7 PERSONNEL REQUIREMENT

7.1 General

Staff and workers requirement for the G.R.P. pipes factory is set herebelow. The payroll will amount to 55 full time.

7.2 Plant Management And General Services Personnel

Qualification	Required number
- Manager	1
- Accounting	1
- Secretariat	1
- Storekeeper	1
- Forwarder	1
- Guard and drivers	2
- Technical service	1
Total	**8**

7.3 Process Equipment Personnel

Qualification	Continuous line (required number for three shifts)
- Foreman	3
- F.W. operator	9
- bell operator	6
- Electricians and mechanics	2
Total	**20**

7.4 Fitting Manufacturing, Prefabrication, Testing and Handling

Qualification	Continuous line (required number for three shifts)
- Foreman and leading operator	1
- Laboratory operator – quality control	2
- Workers	3
Total	**6**

7.5 Total Manpower

The personnel of the factory is then composed as follows:

- manager 1

- superintendent 3

- clerks/ workers 30

8 TRAINING OF LOCAL PERSONNEL

Course of training in management, operation and maintenance of the new factory, will be held for a team of local skilled personnel in order to assure the continuity of working capability and to transfer the necessary know-how. The training is related to the personnel employed for the initial manufacturing phase of the factory.

8.1 Location Of Courses

Training courses will be held at Buyer's factory directly on equipment, where duly qualified technicians will provide all the necessary practical and theoretical instructions on the process technology, on the correct operation and maintenance of machinery, and on the design of pipe product and .

8.2 Personnel To Be Trained And Course Duration

On the basis of the personnel requirements for the factory correct operation and managing, it is considered that 6 skilled people should be trained for a duration of 10 working days.

9 KNOW HOW, ENGINEERING DESIGN AND DOCUMENTATION SUPPLIED

9.1 Preliminary Design

It includes a preliminary layout of plant based on its working flow-sheets, as well as the complete list of machines and tools needed for production and relevant to both process and facilities.

This preliminary design will be consolidated into a Technical Report, which will include also all data relevant to production yields, as well as a detailed costs estimate.

9.2 Know How And Engineering

Based on the above document, the supply of the know-how and engineering shall consist of the following documents referred to the plant as described in the Technical Report.

9.2.1 Basic Design

- Design Of Civil Works
- Mechanical Design
- Electrical Design
- Executive And Detailed Design Work
- Machines To Be Supplied – Technical Description
- Operating Handbook
- Engineering Handbook

All the above documents, except the ones for mass-produced equipment, will be supplied in English language in two copies.

10 TECHNICAL SERVICES AND PLANT COMMISSIONING

10.1 Plant Erection Supervision

We will supervise the works relevant to the erection of the plant.

10.2 Start Up, Commissioning and Training

Start up and commissioning of the whole plant will be provided by a team of experts as follows:

- 1 plant superintendent.
- 1 continuous filament winding machine specialist.

The above team will also undertake training of operating personnel at site in order to enable them to operate the machine independently and in optimum way .

10.3 Acceptance Test Procedure

10.3.1 Purpose

The purpose of the acceptance tests is to prove completeness, correctness and reliability of the machines equipment and technical documentation supplied by our company and examine the quality of the contract products, which will be manufactured in the buyer's plant.

In order to execute the contract smoothly, our Company will carry out, through his specialists, the supervision of the erection, commissioning and performance tests of the plant.

We will send to customer's country properly qualified personnel, capable of correctly carry-out the above specified tasks as well as overcoming any technical problem that may arise during this period. Our personnel will answer in detail any eventual technical queries the buyer's specialists may have, concerning the fulfillment of the contract, and assist the customer in training the latter's specialists, in customer's plant, for a period of two weeks.

The buyer shall provide the necessary skilled personnel, equipment and raw materials for the erection, commissioning, performance tests and start-up of the plant.

The exact date of arrival and departure of our technical personnel, to and from the buyer's plant shall be discussed and mutually established by both parties, according to the actual progress of the scheduled work program.

The buyer undertakes to make available at his own expenses, suitable board, lodging and transportation for our personnel during their stay in customer's country.

10.3.2 Content and method

The technicians of both parties shall carry out in customer's country an acceptance test on the machines and equipment, supplied by our company.

Definition of idle test run:

At first, each machine and equipment supplied by us shall be tested separately after their installation, in idle operating conditions to assure that there are no stronger vibrations, no louder noise levels and no higher idle power requirements than those which will be specified.

The drawings we will supply, concerning machines and equipment which shall be made by the customer, shall be complete, correct and reliable. The machines and equipment, built according to the drawings mentioned above, shall be in accordance with the manufacturing process requirements.

Definition of production run:

During the production run one (1) piece of typical products, shall be manufactured by our technicians, in the contract plant and in accordance with the technical documentation.

Each of the above detailed products shall be checked and tested in customer's country, according to our standards and specifications (two) and in presence of both parties' representative. The expenses for the acceptance test in customer's country shall be totally borne by the customer.

If the test results show that the performance of all stated products is in conformity with the specified technical features, both parties will sign four (4) copies of the Acceptance Certificate; two (2) copies for each Party.

It is furthermore hereby understood that the raw materials employed in the test runs, must be of the same quality as those specified in the technical documentation.

Test time

Both parties shall complete the tests within fifteen (15) days.

If the performance tests cannot be successfully performed, within the stipulated days, our personnel will remain on site to help the customer in this respect for a period of ten (10) days beyond the concurred fifteen (15), at the same terms and conditions.

10.4 General Assistance

We will supply you with all standards, specifications and shop drawings relevant to pipes of each class, diameter and service pressure series.

Moreover our design office will be at your disposal for studies relevant to special applications, as well as technical and organization problems relevant to the applications of the above pipes.

10.5 Running Assistance

We shall place at your disposal, for the length of time specified above, our experienced personnel as needed for the running operations of the plant. Furthermore we will supply all information relevant to any technological advancements of our Italian operations, so that the plant could benefit of it.

10.6 Training on Site

We will assist the customer in training the latter's specialists, in customer's plant, for a period of two weeks.

11 EXCLUSIONS FROM THE SUPPLY

Purchase of industrial area, urbanized and leveled, with connection to power, telephone and water system, construction of industrial buildings and offices are not included in the supply.

Moreover, the following general services and utilities should be provided on site and should be at Customer's charge:

- warehouse and maintenance equipment (electric, electronic, mechanical)

-electric power network and lighting

- air compressor and compressed air network

-fire fighting network and hydrants

- raw water pumps and network

- main external storage tanks, main resin transfer pumps and resin piping up to the daily resin mixers , daily resin mixers with stirrers, resin piping system from daily mixers up to resin dosing pumps ,resin piping from storage tanks up to sleeve coupling machine

-ventilation system

-sand storage tank

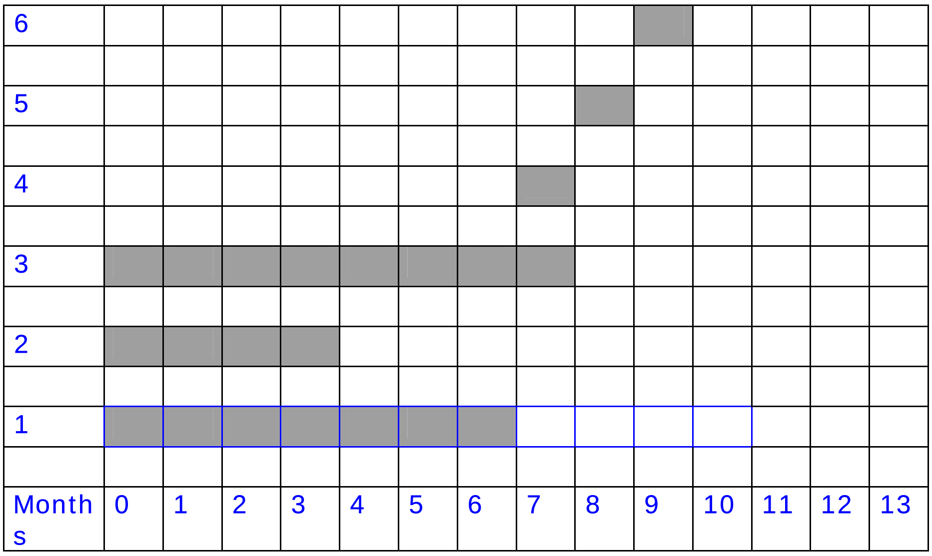
electric transformer

- diesel generator set

-two frontal fork lifts and one side fork lift

12 ACTIVITIES

PROGRAM BAR CHART



0 APPROVAL OF THE CONTRACT

1 CONSTRUCTION OF PROCESS MACHINERY IN ITALY, TRIAL RUN AT CONSTRUCTION PREMISES AND DELIVERY FOB ITALIAN PORT

2 DESIGN OF THE PLANT

3 CONSTRUCTION OF BUILDING AND UTILITY PLANT IN LICENSEE'S COUNTRY

4 TRANSPORTATION OF PROCESS MACHINERY AND LOCALLY MANUFACTURED EQUIPMENT TO THE INSTALLATION SITE

5 ASSEMBLY

6 TESTING AND START-UP