TURN-KEY
MANUFACTURING PLANT
for
GRP PIPE MANUFACTURING

SUDAN

~ PRELIMINARY OFFER ~

By pursuing the principles of "quality, technological innovation, high-quality service, reputation", we dedicate our excellent products with good price and service to society and people.

1. General

Glass **R**einforced **P**olyester pipes are manufactured from polyester resins and fibrous glass reinforcements and depending on type with inorganic filler. The design philosophy of GRP pipes is to provide products with suitable properties and the required margin of safety, that will enable the pipe to perform satisfactory after an extended period of operation (more of 50 years) under typical service conditions.

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

Discontinuous line for the production of GRP pipes with diameters from 100 to 1000 mm.

The present quotation incorporates within its scope all necessary machinery, equipment, apparatus and installations that are required for the manufacture of GRP Pipe. The only items that are outside the scope of this quotation are mainly land, construction, infrastructure works, etc.

2. System design

2.1. Products

The final product to be manufactured in the plant is **GRP Pipe.**
The specific capacity of the plant has been designed such that the plant may adjust production in accordance with the requirements of the project.

2.2. Advantages in GRP Pipe Application

Glass reinforced Polyester pipes represent the ideal solution for the abduction of any kind of water, chemicals, affluent 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:

Higher mechanical resistance due to the glass reinforcement.

Corrosion resistance, both of the external wall and internal wall in contact with the conveyed fluid. No protections such as coating, painting or cathodic are nedeed. GRP pipes are resistant to nearly all chemicals even at much higher temperatures (up to 170 °C) than other plastic materials.

Smoothness of the internal wall that minimizes the head losses and avoids the formation of deposits on the other hand minimizes the slope.

Very long life, virtually infinite, of the material which does not need maintaining.

Absolute impermeability of pipes and joints both from external -to internal and vice-versa.

Low weight of pipes lengths that allows for the use of light laying and transport means.

Length of sections larger than other materials ones.

Easy installation procedures because laying of GRP pipes is a simple operation which can be done in short periods of time both above and below ground, since spigot and socket joints enable fast and reliable assembling.

Workability of the material on sites employing simple equipment.

Possibility of nesting of different diameters of pipe thus allowing additional saving in transport operations.

In particular, we have developed a proper know-how for the following products:

Water supply pipes 200 - 2600 mm dia. From 25 bar to 10 bar according to dia, using vinylester or bisphenolic or isophthalic resin and bell and spigot joint with double 0-ring designed according to international standards (ASTM-AWWA).

Low pressure pipes could be sand filled in order to reach a better stiffness and lower cost.

Sewerage system 100-3000 mm dia. With pressure up to 6 bar isophthalic resin and bell and spigot joint with double 0-ring. These pipes can be sand filled up to 60% with a substantial reduction in costs and improvement in stiffness, designed according to international standards (ASTM - AWWA)

Oil flow line 50 - 250 mm dia. Vinylester resin, with pressure up to 200 bar, braised joints, designed according to API standards.

2.3.Fields of application of G.R.P. pipes

- Water distribution both civil and industrial
- Sewer systems both urban and industrial
- Water intakes for cooling water systems
- Waste water out falls to sea
- Sealines and river crossings
- Process lines for industrial plants
- Fire fighting network
- Gasoline handling and distribution network
- Corrosive fluids and vent gas stacks
- Well casing and wells pumps risers
- Penstocks
- FGD (flue gas desulphurization)
- Irrigation networks
- Flue gas stack

3. GRP Pipe Product Characteristics

3.1. 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:

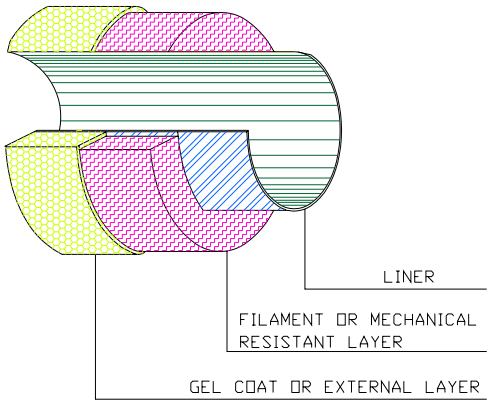
It is in direct contact with the conveyed fluid and guarantees the maximum resistance to the chemical attack from the fluid itself. Moreover, the liner presents an internal surface particularly smooth, without defects, cracks or delaminated zones. The liner is composed of one glass veil and one glass 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 depends, then, upon the design, conditions. The mechanical layer is composed of continuous glass filament roving resin impregnated.

- gel coat or external layer:

It has a thickness of about 0,2 mm and consists of pure resin without glass reinforcement. It guarantees the complete impregnation of the peripheral fibres, thus yielding the external pipe surface completely free of protruding fibres and well finished. The external coating is always added with ultraviolet ray inhibitor in order to prevent the nearly negligible weathering effects.



3.2. Diameter and classes

- Nominal Diameter:

GRP pipes are manufactured in diameters ranging from 25 mm to 3000 mm.
Nominal diameter coincides with the internal diameter
Any nominal diameter can be manufactured
Larger diameters can be manufactured at side by means of special equipment

- Nominal Pressure Classes:
Nominal pressure classes are 4, 6, 10, 16, 20, 25 bar
Intermediate or higher pressure classes are considered on request or depending on the design conditions

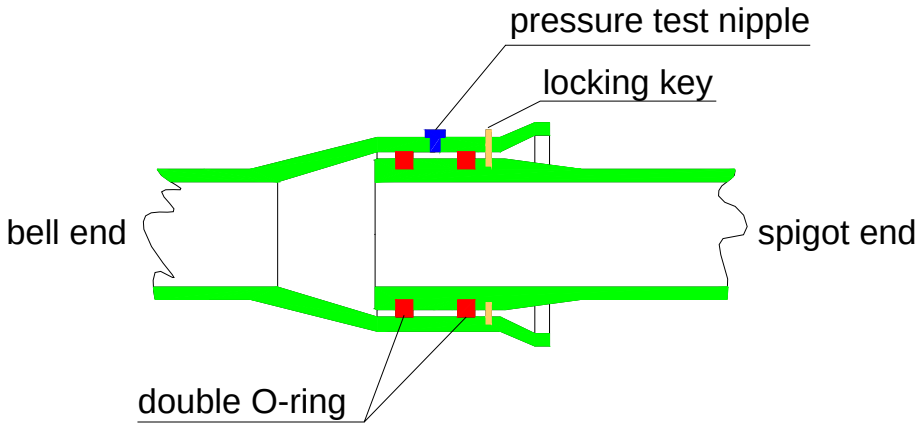
- Specific Pipe Stiffness Classes..
Pipes are also classified according to specific pipe stiffness Specific pipe stiffness classes are 1250, 2500, 5000 and 10000 Pa.
Intermediate or higher specific pipe stiffness classes are available on request or Depending on the design conditions

3.3. Pipes ends

The most common type of G.R.P. pipes ends coupling is the bell and spigot one that allows ease installation of sections and very good hydraulic sealing by means of rubber gaskets. The supplied pipes manufacturing equipment and moulds are then foreseen in order to produce bell and spigot pipes ends. This kind of joint can be moreover completed with locking device that assures axial continuity to the pipes. Anyway, it is possible to produce also plain ends pipes to be joined by means of chemical welding and usually employed in aerial installations or to manufacture particular fittings. Tolerances in the bell and spigot joint are very limited because the bell is produced by mould, together with the remaining pipe (monolithic bell) while, the spigot, is obtained by high precision machining equipment.

- **Hydraulic sealing**

The hydraulic sealing for bell and spigot ends pipes is obtained by means of one or two elastomeric toroidal gaskets (O-Ring), installed into circumferential grooves machined on the spigot end. The mentioned scheme of bell and spigot report the position of the gaskets on the spigot end. For plain ends pipes, the sealing is assured by sleeve joint or chemical welding that presents the same characteristics of resistance and impermeability of the pipes itself.



BELL AND SPIGOT JOINT

3.4. 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 includes:
-different degree bends (by moulds or pipe pieces)
-equal tee or reduced tee (by moulds or pipe pieces)
-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.

4. MANUFACTURING PROCESS

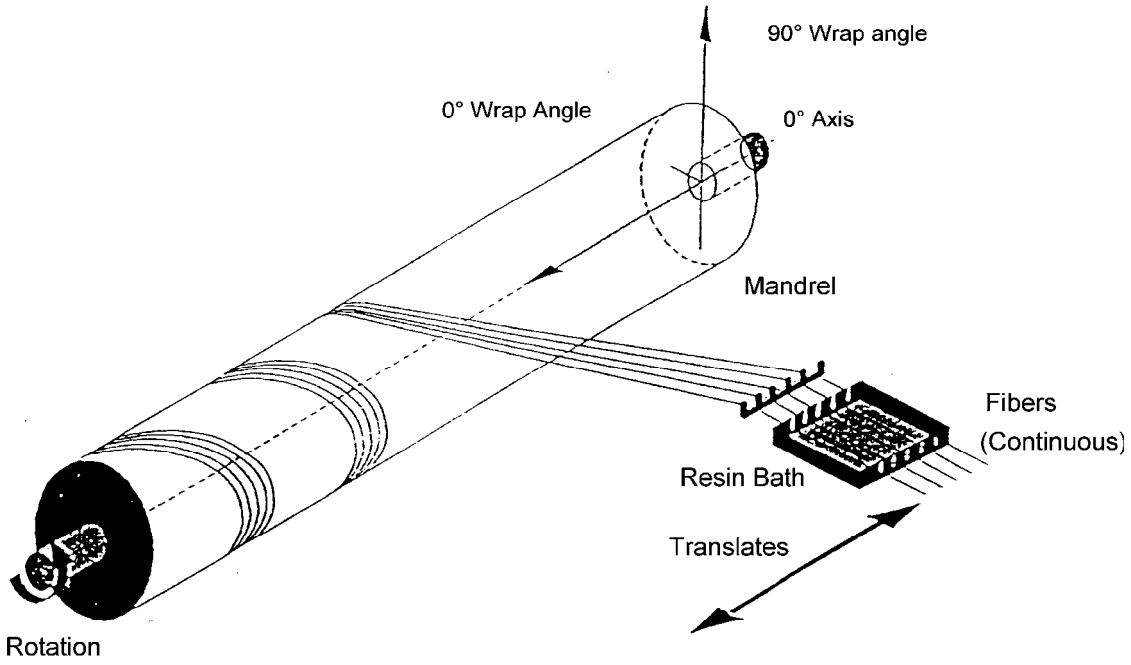
The manufacturing processes are used for G.R.P. pipes:

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

4.1-Discontinuous Filament Winding

The manufacturing process proceeds step by step as follows:

This process manufactures G.R.P.pipes in standard lengths (usually 12 mt)



on rotating mandrel. By adjusting the relative speeds of mandrel rotation and glass distribution head movement, helical reinforced pipe is formed. Adjusting the raw materials ratio, which can include high purity silica sand, can also change pipe properties.

The discontinuous production of GRP pipes through the filament winding process, avails itself of a mandrel which surface is made of a steel.

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 glass fiber

(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
- 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 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.

The resin which is already mixed with catalyst in the due proportion. Mixing operations are carried out in two different mixers, one for each feeder. 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.

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.

Main characteristics of this process are the following:
- bell and spigot joint
- bell and spigot ends, monolithic with the pipe wall
-by changing the winding angle different axial and hoop characteristics can be obtained
Pipes manufactured by Discontinuous Filament Winding are used for:
- gravity
- medium, high pressure
- any underground and aboveground application

4.2 Testing

Manufacturing of pipes is subjected to constant checking. The checks are carried out on raw materials, at each production phase and, lastly, on the finished product.

The mechanical strength of finished products is tested periodically on lengths of pipe chosen at random from standard products. The test consists in reproducing the conditions which the pipe will have to undergo during working and also, in a dimensional check. The inspected pipe, if accepted, is indelibly marked with indications relevant to Manufacturer lot, manufacturing date, diameter, pressure class and then it is sent to the factory stockyard waiting for shipping.

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
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.

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
- 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. PROCESS EQUIPMENT

The plants normally proposed are the following:

5.1. Discontinuous Filament Winding

Characterised by high product flexibility, suitable for the production of GRP pipes both with sand (through the new system for the application of pre-mixed sand/resin compound onto the pipe) and without. The production range includes pipes that withstand both high and low operating pressure (according to the type of joint), within any market segment:

FM1000 Line

Nominal diameter	ND 100 - 1000 mm
Nominal bar length	12 mt
Nominal pressure	up to 25 bar
Stiffness	up to 10.000 N/m^2
Filling with inert	up to 60%
Joining	bell and spigot
Average prod. capacity	***2000 ton/year pipe of 900 mm pipe based on one production shifts/day for 300 working days/year***

6-PRODUCTION EQUIPMENT SUPPLIED

All process equipment and utilities, services, installations and services required for the proper operation of the plant and within the scope of the project have been clearly indicated. All other items and infrastructure that have to be provided by the Client have been indicated separately to visualize the total scope of the investment. All equipment depicted with relevant technical details in this document are being offered as installed in their positions, all connections completed and ready for operation.

Discontinuous Filament Winding machine consists of:

-Liner Making Machine
-Winding Machine
-Curing Station
-Calibration Machine
-Gantry Ejection Machine
-System of Mixing Resin

Specification of production are φ100mm~φ1000mm GRP RMP pipe, length is 12M.

6.1.Scope of supply of equipment:

2.1. DNφ100-1000x12000mm Liner Making Machine(17kw)	1 set
1) Drive head of liner making machine	1 set
2) Tail of liner making machine	1 set
3) Railway of liner making machine(16m)	1 set
4) Carriage of liner making machine	1 set
5) System of timing with frequency conversion	1 set
6) Electric control system	1 set
7) System of feeding-resin	1 set
2.2. DNφ100-1000x12000mm GRP Pipe Winding Machine (27Kw)	1 set
1) Drive head of winding machine(ladder) (one axis two gear)	1 set
2) Tail of winding machine(ladder)	1 set
3) Railway of winding machine(20m)	1 set
4) Winding carriage	1 set
5) Reinforce-mortar carriage	1 set
6) Resin groove type soaking in bottom	1 set

7) Draw-fibre shelf type simple	1 set
8) System of timing with frequency conversion	1 set
9) Control system of computer, main electric control board and accessorial electric control board	1 set
10) Reinforce-mortar head type oblique-under-side and electric control board	1 sets
11) System of feeding-resin	1 sets
12) Air pressing roll(400kg)	1 sets
13) bracket of mylar	
14) Groove of catching resin	1 sets

2.3. DNφ100-1000x12000mm Curing Station (25.6kwx4=102.4kw)	4 sets
1) Drive head of curing station	4 sets
2) Tail of curing station	4 sets
3) Infrared heating device	4 sets
4) Electric control system	4 sets
2.4. DNφ100-1000x12000mm Calibration Machine(16.5kw)	1 set
1) Drive head of calibration machine	1 set
2) Tail of calibration machine	1 set
3) Calibration head	1 set
4) Electric control system	1 set
5) Spray and dust remove device	1 set
2. 5. DNφ100-1000x12000mm Gantry Ejection Machine(32.9kw)	1set
1)Gantry ejection stop stand (including four hydraulic telescopic arms)	1 set
2) Ejection small carriage	2 sets
3) roller of Hydraulic	1 set
4) Tractor	1 set
5) 5T windlass and its foundation	1 set
6) Hydraulic system	1 set
7) Electric control system	1 set
2.6. System of Mixing Resin(21kw)	1 set
1) Mixing tin of liner layer (with two pumps)	1 set
2) Mixing tin of structural layer (with two pumps)	1 set
3) Pipe valve and accessory	1 set

2.7. Other

1) Quartz sand store receptacle($2m^3$) 1 set
2) Quartz sand transfer receptacle($0.3m^3$) 1 set

Total Power of Capacity: 191.2Kw +2% (Without Power of Capacity of the Air Compressor, Travelling Crane and Testing Equipments)

6.2 - Technical capability of product line

1. General explanation:

2. Technical Capacity:

2.1 Liner making machine:

Specification of production: DNφ1000x12000mm

- Power of main axis: 11KW
- power of carriage of liner making machine: 3KW
- Main axis and carriage is timing with frequency conversion
- Feeding-resin system: Flow:0-20KG/min.
- Flow is regulated with frequency conversion. Power: 3KW

2) Use and characteristic

Use:

This machine is specially used in the GRP pipe product line for making the inner liner of pipe.

Characteristic:

- The carriage is moving by driving the main axis. Two of them can disjoin as well as interlock. It is to be adjusted the span while disjoining, and to be adjusted the speed while interlocking.
- Carriage of liner making machine is equipped with a feeding-resin system and a head of pouring-resin. No manual work of resin-brush is needed.
- This machine is equipped with a shelf of winding polyester film and 4-roller air pressing roll to wind polyester film and glassfiber mesh. The 4-roller air pressing roll can remove air bubble from the inner liner.

3) Configuration and method:
This machine consists of:

- Railway of liner making machine
- Drive head of liner making machine
- Tail of liner making machine
- Carriage of liner making machine
- Electric control system
- Feeding-resin system
- Head of pouring-resin
- Air pressing roll
- Shelf of winding polyester film

The mould used for making pipe is circumvolving by the drive head of liner making machine; the carriage setting on the railway keep moving left and right along the axial of mould. At the same time, the electric control system, feeding-resin system, air pressing roll and shelf of winding polyester film setting on the carriage do the process of laying and soaking resin by polyester film, surface mat, and woven roving on the mould. So the process of making liner is finished.

2.2 Winding machine :

Main technical data of the winding machine:

- Power of main axis: 15kw
- Power of winding car & reinforce-mortar carriage: 4kw
- Power of feeding-resin system: 3kw x 2= 6kw
- Power of lifting device of reinforce-mortar head: 1kw

Specification of production: DNφ100-1000x12000mm

- Accuracy of draw-fiber: ±0.5mm
- Winding angle: ≥45°≤90°
- Speed of draw-fibre: ≤130m/min
- Form of winding: screw or round change automatically
- Form of control: manual, auto loading, automatic
- Form of draw-fibre: linear
- Form of reinforce-mortar: reinforce mortar at obligue-under-side with multilayer each time
- Form of drive: drive by rack

The winding length as L, the width of reinforce mortar roving as B, the winding angle as a, and the length of resting on the end as c. When the winding length L is fixed, any two parameters of the other three can be fixed.

The top or the end of a pipe can be winded as the zero point of winding.
This machine can directly change from the form winding by round with single layer to the form winding by screw.
This machine can pour mortar, flow-in resin, reinforce mortar in each time, and it can continuous reinforce mortar to and from.
Auto thickening at the inserting end of pipe.
The feeding-resin flow of feeding-resin system for reinforce mortar and pouring-resin is 45kg/min(timing with frequency conversion). The thickness of reinforce mortar each time come up to 4-20mm. The thickness is not influenced by man-made and too-heavy of mould. The difference between design thickness and actual thickness (after pressing by roll) is 1.5-2mm.

2) Use and characteristic

Use:

This machine is the best important equipment of the GRP pipe product line for winding and making reinforce mortar on the structural layer of a GRP pipe.

Characteristic:

- The main axis is circumvolving and the winding car is moving with a

setting mathematical model controlled by a computer in a manual, auto-loading or automatic form.

- This machine has been equipped with two feeding-resin systems, two heads of pouring-resin, one set of air pressing roll, one resin groove type soaking in bottom, one reinforce-mortar device, one shelf of winding glassfiber and one electric control system on the winding car and the reinforce-mortar carriage. The winding car can load people and can control the whole winding process and reinforce mortar process on the structural layer by an electric control system.
- Winding car and reinforce-mortar carriage are drove by rack accurately and smoothly.
- The form of reinforce-mortar is to reinforce mortar at oblique-under-side with multi-layer each time and the thickness of reinforce mortar each time come up to 20MM. The resin content of reinforce-mortar layer is controlled by the computer and its accuracy come up to ±3
- The speed of draw-fibre increases from 54m/min as the standard speed was to 100m/min.
- Use original product of SIEMENS of Germany as the servo system for a high operational reliability.

3) Configuration and method:

This machine consists of:

- Railway of winding machine
- Winding car
- Resin groove type soaking in bottom
- Reinforce-mortar carriage
- Reinforce-mortar device
- Air pressing roll
- Fibre glass shelf
- Feeding-resin system
- Head of pouring-resin
- Cable shelf
- Control system
- Drive head of winding machine
- Tail of winding machine
- Groove of catching resin

The drive head of winding machine drive the pipe mould to circumvolve;

The winding car equipped on the railway moving with a setting mathematical model to and fro along the axial of the pipe mould, and winds the glass fiber from the resin groove type soaking in bottom on the pipe mould.

While the reinforce-mortar device is putting quartz sand with a setting thickness and setting resin content on the pipe mould, the feeding-resin system and the head of pouring-resin feed a setting volume of resin to the resin groove type soaking in bottom and on the quartz layer.

The air pressing roll presses air bubbles out from the reinforce-mortar layer for pressuring solid. So the process of making structural layer of pipe is finished.

2.3 Curing Station:

1) Main technical data of the curing station
a. Speed of main axis: 5rpm
b. Power: 4kw
c. Infrared heating board: 24 piecesx0.9kw=21.6KW

2)Use and characteristic

Use:

This machine is specially used in the GRP pipe product line for making the inner liner layer or structural layer of pipe for solidifing.

Characteristic:

The main axis rotates the pipe mould. Heat with infrared. The structure is simple.

3) Configuration and method:

This machine consists of:

- Drive head of curing station

- Tail of curing station
- Infrared heating board
- Electric control system

The drive head of curing station rotates the pipe mould, which has finished its inner liner or structure layer, to avoid resin flowing down.

The infrared heating board which are equipped beside heats the inner liner or structure layer to accelerate for solidifing.

2.4 Calibration Machine:

1) Main technical data of the calibration machine

- Power of main axis: 7.5KW
- Calibration power: 7.5KW
- Power of water pump: 0.75Kw
- It can calibrate 1/32 taper and the joint of double seal ring type-O
- Form of dust collection: water tank (moveable)
- Diameter of calibration: φ100-1000MM Length: 12000MM
- Mode of speed controlling: timing with frequency conversion

2) Use and Characteristic

Use:

This machine is specially used in the GRP pipe product line for calibrating the joint of GRP pipe.

Characteristic:

- Calibrating the pipe with mould. Simple structure and operation.
- The main axis is rotating and the calibration head is moving fore and aft with a form automatically. A lead screw drives the cutting feed.
- The main axis is rotating and the calibration head is moving fore and aft with a speed automatically and changeable.
- Calibrating the joint of pipe with a forming cutter in one time

3) Configuration and Method

This machine consists of:

- Railway of calibration machine
- Drive head of calibration machine
- Tail of calibration machine
- Calibration head
- Electric control system

The drive head of calibration machine rotates the mould with the pipe which is required for calibration. The calibration head with a forming cutter which equipped on the railway calibrates the joint of pipe after adjusting the span.

2.5 Gantry Ejection Machine:

1) Main technical data of the gantry ejection machine:

Specification of production: Diameter: φ100-1000MM

- Length: any length
- Ejection force: 70T
- Power of main oil pump: 11KW
- Traction force of windlass: 5T
- Power: 7.5KW
- Ejection big car and tractor can step automatically

2) Use and characteristic

Use

This machine is specially used in the GRP RMP pipe product line for ejection the GRP pipe.

Characteristic

This machine is equipped a gantry ejection device with strong traction force and work smoothly.

- Making ejection force by a hydraulic oil cylinder with overload protective device and it has a nice force.
- Both the ejection big car and the tractor can step automatically for simplifing the ejection process and raising the ejection efficiency.

- It has a large ejection span with diameter from DNφ100mm to φ1000mm and the length is unlimited.

3) Configuration and method

This machine consists of:

- Gantry ejection stop stand
- Ejector
- Telescopic arm
- Ejection small car
- Roller of Hydraulic
- Tractor
- Windlass

While the telescopic arm is fixing the ejection ring of pipe mould, the tractor fixes the joint of pipe mould, then force a pulling to take out the pipe from the mould by the force of hydraulic ejector. The ejection samll car carries the pipe with mould before ejection as well as the pipe after ejection, while the ejection roller of Hydraulic and the tractor carry the pipe mould after ejection. So the ejection process is finished.

2.6 System of Mixing Resin:

Main technical data of system of mixing resin

- Power of mixing tin: 3kw x3=9kw
- Power of gear pump: 3kw x 4=12kw
- Mixing tin: more than $1.2m^3$
- Mixing speed of impeller: 200rpm
- Gear pump: Flow: 20L/min

2) Use and characteristic

Use:
This machine is specially used in the GRP pipe product line for supply with pre-mixing resin added hardener for the GRP pipe product line.

Characteristic:

The resin is fed into the tin and out the tin by the gear pump for reducing the labour intensity of the workers.

3) Configuration and method

This machine consists of:

- Mixing tin
- Impeller for mixing
- Gear pump
- Electric control system

The resin is fed into the mixing tin by pump, then add hardener into and mixing for 20 minutes, and then feeding the resin by pump to the using resin place. So the mixing resin and feeding resin process is finished.

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, mechanical sailing parts of dosing pumps, protecting rubber parts on sand roller.
It is required to make a weekly complete cleaning of dosing pump.

3.1 Detailed Technology Requirement for Making GRP Pipe Winding Machine:

Main axis: Domestic normal electric motor. Coder and system of timing with frequency conversion are made by the SIEMENS of Germany. Power of the electric motor of main axis is 11KW
Winding car: Servo motor, coder and system of timing with frequency conversion are made by the SIEMENS of Germany. Winding car can load people and it setup accessorial electric control board to control the whole winding process. Torque of the winding car is 16N.m
Resin groove type: Type soaking resin in bottom. Equipped with a resin controllable sweep board and a pectinate winding head.
Fibreglass shelf: Mechanical type tensile force, adjustable, can load 80 spindles fibreglass.fibre is drawn from spindles core
Computer: Industry Control Computer and Made in Taiwan (586), the control software is the excursion system with no zero point made by Manufacturer.
Control board: cold plate, sprayed surface, domestic high quality electronic component.

6.3. Production Capacity

We have taken into consideration that the plant will operate on one shift of total 8 hours per day and the capacity of the major equipment have been designed to fulfill the required quantity within this period.

This also means that in the future, as market requirements grow, the plant may double or triple its manufacturing capability simply by increasing the number of working shifts per day.

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 design considerations for the capacities of key points of the system are discussed in the following table:

The proposed factory is sized for an average manufacturing capacity of 2000 ton/year of finished glass fiber pipes with average diameters of 100 - 1000 mm, based on 1 shifts of 8 working hours each shift, and on 300 working days/year, with pipe dia 900 mm production.

7. Raw Materials

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

7.1 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.

7.2-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 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.

7.3 - 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

7.4 - THE TECHNICAL DATA & TEST STANDARDS OF RAW MATERIAL

Raw material of for the GRP pipe

1. E-Glass Glassfiber(filament winding roving):

No.	Item	Specification	Test Standard
			ISO
1	Appearance	Clean, no contamination	-------
2	Glass Type	E-Glass, Alkali content≤ 0.8%	-------
3	Size Type	Silane	-------
4	Compatible resin	UP, VE	
5	Filament Diameter (μm)±1	14~24	ISO1888
6	Strands Density Tex(g/km)	2400	ISO1889
7	Tensile Strength (N/tex)	≥0.30	ISO3341
8	Roving Density Tex(g/km)	±5%	ISO1889
9	Loss on ignition (%)	0.40±0.10	ISO1887
9	Moisture content (%)	≤0.20	ISO3344

2. Resin for liner layer Grade food(ISO):

No.	Item	Specification	Test Standard
	Technical data of liquid resin		
1	Appearance	Clean, ropy liquid	eyeballing
2	Acid Value(mgKOH/g)	8-14	
3	Viscosity(23oC)(mPa.s)	300-550	
4	Gel Time(min) (25oC-35)	15-25	
5	Non-Volatile(%)	55-60	
6	Thermal Stability(80oC)(h)	≥24	
	Data of Typical solidifing		
	Air bath at 25oC, adding MEKP-IIA 2ml & Promoter 1ml every 100ml		
	Data of pouring-resin object		
1	Barcol Hardness (Barcol)	≥35	
2	Tensile Strength (Mpa)	≥50-60	
3	Tensile Modulus (Mpa)	≥3000	
4	Elongation at Break (%)	≥3.0	
5	Flexural Strength (Mpa)	≥100	
6	Flexural Modulus (Mpa)	≥3000	
7	Impact Strength (KJ/m^2)	≥10	
8	H.D.T	≥70	
	Sanitary Standard		

3. Resin of structural layer(ORTHO):

No.	Item	Specification	Test Standard
	Technical data of liquid resin		
1	Appearance	Clean, ropy liquid	eyeballing
2	Acid Value(mgKOH/g)	20-26	
3	Viscosity(23oC)(mPa.s)	300-550	
4	Gel Time(min) (25oC-35)	17-25	
5	Non-Volatile(%)	59-65	
6	Thermal Stability(80oC)(h)	≥24	
	Data of Typical solidifing		
	Air bath at 25 , adding MEKP-IIA 2ml & Promoter 1ml every 100ml		
	Data of pouring-resin object		
1	Barcol Hardness (Barcol)	≥35	
2	Tensile Strength (Mpa)	≥60	
3	Tensile Modulus (Mpa)	≥3000	
4	Elongation at Break (%)	≥2.6	
5	Flexural Strength (Mpa)	≥100	
6	Flexural Modulus (Mpa)	≥3000	
7	Impact Strength (KJ/m^2)	≥10	
8	H.D.T ( )	≥70	

4. Polyester film:

No.	Item	Specification	Test Standard
1	Weight (g/□)	53±2	
2	Width	200mm	
3	Tensile Strength(Mpa)	≥17	
4	Elongation at Break (%)	≥8	
5	Ratio of shrink(%)	≤2.0/≤1.5	

5. Glassfiber surface mat:

No.	Item	Specification	Test Standard
1	Appearance	Even, tight, without defect like oil spot, stain, hole, fiber gather	eyeballing
2	Weight (g/☐)	30±5	
3	Width	300mm	
4	Moisture (%)	SH≤0.5 ,CR≤0.9 SH is the type hand lay-up, CR is the type winding	
5	Loss on ignition (%)	6-12	
6	Filament diameter (μm)	9-13	
7	Tensile Strength (N/50mm)	SH50≥25 CR50≥20	
8	Wet-out time (two layers)(s)	SH50≤30 CR50≤17	

6. Terylene mesh fabric:

No.	Item	Specification	Test Standard
1	Appearance	White, even, without spot, stain	
2	Width (mm)	230 ±10	
3	Weight (g/☐)	53±3	
4	Material made by	100% terylene(21/2 strand)	
5	Longitudinal-strand	7 pieces/cm	
6	Latitudinal-strand	4 pieces/cm	
7	Tensile Strength	≥400kg	
8	Moisture (%)	< 0.015	

7. E-Glass Knitting mat:

No.	Item	Specification	Test Standard
1	Roll width	300±3 (mm)	GB/T4667-2001
2	Weight	380(g/m²)	GB/T9914.3-2001
3	Compatible resin	UP	
4	Applying process	Hand lay-up and filament winding	
5	Loss on ignition	1.0□7.0(%)	GB/T 9914.2
6	Moisture	≤0.20(%)	GB/T9914.1-2001

8. E-Glass chopped strand mat:

No.	Item	Specification	Test Standard
1	Coupling agent	Polyester	
2	Weight (g/□)	450	GB/T7690.5-2001
3	Width(mm)	1040	GB/T7690.5-2001
4	Filament diameter	9-13μm	GB/T7690.5-2001
5	Moisture	≤0.20%	GB/T9914.1-2001
6	Loss on ignition	2.0%-8.0%	GB/T 9914.2
7	Binder type	Powder or Emulsion polyester	
8	Compatible resin	Polyester	

9. Wrapping mortar gauze:

No.	Item	Specification	Test Standard
1	Width	300mm±10	
2	Weight	63±3g/□	
3	Material made by	100% terylene(32/2 strand)	
4	Longitudinal-strand	9 pieces/cm	
5	Latitudinal-strand	8 pieces/cm	
6	Tensile Strength	≥1000kg	
7	Moisture (%)	< 0.015	

10. Quartz sand:

No.	Item	Specification	Test Standard
1	SiO_2 Content	95%	
2	10 mesh~60 mesh		
3	Moisture	≤0.2%	

11. Solidifing additive(Methyl Ethyl Ketone Peroxida):

No.	Item	Specification	Test Standard
	Model: MEKP-IIA		
1	Appearance	White, Clean liquid	
2	Activated oxygenous content	9~10.0±0.2%	
3	Flash point	>85□	
	Stability		
1	Starting resolved temperature	50~55□	
2	Temperature of transport	<50□	
3	Temperature of store	<40□	
4	Store period	6 months	
	Transportation	Danger classification	

12. Promoter(COB-I):

No.	Item	Specification	Test Standard
1	Appearance	Purple, clean liquid	
2	Cobalt content	0.6%	
	Caution:		
1	Prohibit to store with Solidifing additive(MEKP-IIA)		
2	Prohibit to meet directly with Solidifing additive(MEKP-IIA) for avoiding explode		

8. Engineering and Technical Assistance

All basic and detailed engineering work as well as technical assistance services required for the design, installation and operation of the plant in the best possible way are included within the scope of this offer. These services have been described in detail.

9.Training and start-up

The proper training of the plant personnel and the starting up of the plant in the best possible way are included within the scope of this offer and sufficient detailed information have been provided.

10. OUR Guarantees

10.1. Manufacturing capacity guarantee

It is under the guarantee of US that the raw water processing Capacity of the plant will not be below **2000 kg / year**

10.2. Product quality guarantee

It is under the guarantee of us that the pipe manufactured in the plant will meet the minimum quality specifications of ınternatıonal standards.

10.3. Plant and equipment quality guarantee

It is under the guarantee of us that each individual specific process equipment and the total of the process plant will meet the design and quality specifications of quotatıon.

10.4. Technical assistance guarantee

It is under the guarantee of us that all the engineering, know-how, training, supervision and technical assistance services within the scope of this offer will be provided in the best possible way and transferred to the plant within the best proper means.

11. Technical Assistance

The technical assistance services which we will provide for the CLIENT are as follows:

11.1. Basic engineering

The necessary working documentation to be supplied to the Client under Basic Engineering may be summarized as follows:

11.1.1. Architectural

- **Site plan (1/1000 scale)**
- **Architectural drawings for all floors (1/200 scale)**
- **Sections**
- **Elevations**
- **List of architectural rendering**

11.1.2. Civil

- **Design loads**
- **Structural system description**
- **Foundations system description**

11.1.3. Mechanical

- **Process piping specifications**
- **Equipment and piping heat insulation specification**
- **Preliminary equipment construction drawings**
- **Column designs for water, heat, sanitary, ventilation and gas systems**

11.1.4. Electrical

- **System drawings and reports**
- **Line diagrams for high and low voltage energy supplies**
- **Process instrumentation design**
- **Standards, specifications and locations of electrical consumers**

11.1.5. Process

- **Preliminary layout including equipment arrangement plan showing dimensions and**
- **Locations of all equipment**
- **Preliminary flow sheets with itemized apparatuses and machines for the process, indicating stand-by equipment, insulation thickness, scheme of pipelines and instrument**

☐.• **Data sheets with process technique indications for**

- All process equipment
- Pumps, engines and motors

- Tanks
- **Preliminary process description with energy and auxiliary agent scheme, utility flow diagram and list of the measuring and controlling techniques**

11.2. Detail engineering

The necessary working documentation to be supplied to the Client under Detail Engineering may be summarized as follows:

11.2.1. Architectural

- **Architectural drawings (1/50 scale)**
- **Details (1/20; 1/10; 1/5; 1/1 scales)**
- **Furniture settings**
- **All relevant details for architectural rendering**

11.2.2. Civil

- **Statical calculations**
- **R.C. design, structural steel detail drawings**
- **Foundation detail design**
- **Detail drawings of roads, paved areas**
- **All technical infra-structural designs (water supply, sewage, etc.)**

11.2.3. Mechanical

- **Final procurement lists and specifications**
- **Constructional drawings of all equipment to be manufactured**
- **Operation and maintenance manuals of all machinery**
- **Detailed working drawings of all mechanical engineering systems**

11.2.4. Electrical

- **Detailed working drawings for all electrical engineering high and low voltage systems**
- **Detailed working drawings of all process control loops**
- **Final procurement lists and specifications**

11.2.5. Process

- **Final process flow sheets showing all machinery and equipment with item numbers and sizes as well as major process pipes and sizes and instrumentation diagrams**
- **Completion of data sheets**
- **List of machinery and equipment**
- **List of drawings**
- **Preliminary process calculation including chemical**

calculation

11.2.6. Process Manual

A detailed and complete Process Manual will be prepared as built by Umde and handed over to the Client after the Provisional Acceptance as a whole. The Process Manual will consist mainly of the following:

- Documentation for operation and maintenance
- Layout specifications and locations
- Process description
- Process calculation
- Equipment drawings including all data (machines, instruments, tanks, aggregates)
- Piping specifications (type, design, material, dimensions pressure)
- Operation manuals for machines
- Final list of oils and greases
- List of spare parts
- Final drawings of control cabinets and switchboards
- Electrical documentation including lighting plans
- Functional diagrams, one line diagrams, circuit diagrams
- Quantity statement of the material flows, product quantities, utilities, chemicals, raw materials and auxiliaries
- List of drawings
- All laboratory, chemical and microbiological analytical methods
- All technological documents for commissioning
- General operation instructions for the whole plant
- Lubrication plan
- Maintenance instructions
- List for ordering wear and tear parts
- Weekly work diagrams

12. Construction Requirements

Factory Layout And Installations

Total Extension

The factory should cover a rectangular shape plane area of about 10.000 m2, of which 2500 m2 covered area.

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).

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 crane.

"E" And "C" Glass Fiber Distribution System

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

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.

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 CO2 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.

Electric Installations

The total electrical power installed is 250 KVA and considering a contemporaneity of 75% the required power is 175 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.

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).

Open Spaces

Not covered spaces extend for about 8.000 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.

12.1. Land

12.2. Construction costs

The covered areas required in the plant have been summarized below. The necessary construction work and a rough estimation for the construction costs have been provided below only for visualization of the total costs.

No	Construction work to be done	Area	TOTAL (USD)
S-01	Guard house		
S-02	Administration building		
S-03	Plant building		
S-04	Utilities		
S-05	Warehouse		
S-06	Social facilities for workers		
S-07	Access ways, roads, fences, etc.		
	Total construction estimated cost	USD	

IMPORTANT NOTICE : The above is only an approximate budget estimation for costs that may be required for the construction works.

13. Personnel requirements

General

Staff and workers requirement for the G.R.P. pipes factory is set herebelow. The payroll will amount to 20 full time.

Plant Management And General Services Personnel

Qualification	Required number
- Manager	1
- Accounting	1
- Secretariat	1
- Storekeeper	1
- Guard and drivers	2
Total	**6**

Process Equipment Personnel

Qualification	Continuous line (required number for one shift)
- Foreman	1
- F.W. operator	8
- bell operator	1
- Electricians and mechanics	2
Total	**12**

Fitting Manufacturing, Prefabrication, Testing and Handling

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

Total Manpower

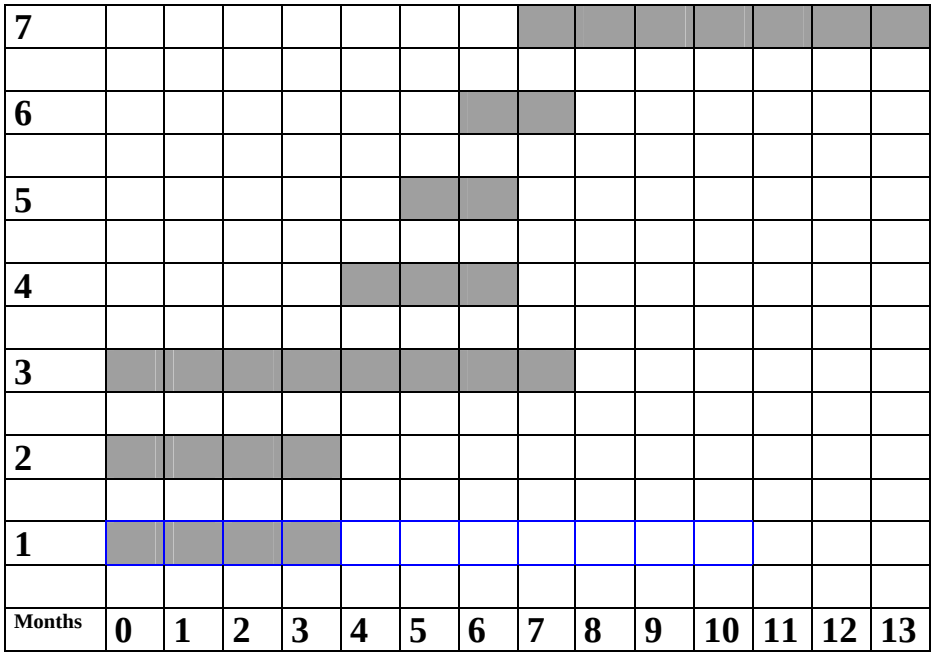
The personnel of the factory is then composed as follows:

- manager 1
- superintendent 3
- clerks/ workers 16

14. Time schedule

ACTIVITIES

PROGRAM BAR CHART



0 APPROVAL OF THE CONTRACT

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

2 DESIGN OF THE PLANT

3 CONSTRUCTION OF BUILDING AND UTILITY PLANT IN SUDAN

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

5 ASSEMBLY

6 TESTING AND START-UP

7 PRODUCTION