Production line for glass fiber reinforced plastic rebar

UAE, Dubai, Jumeirah Lakes Towers, Platinum tower, Star Business Center, Office 805-03
Tel: +971 55 499 4675
Email: composite.trading@gmail.com
http://www.petroleum-trading.com

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Technology.
The technological process of production of fiberglass reinforcement is based on the development of rebar of continuous glassfiber filaments, imbued with a plastic binder together with the next process of hot hardening, going on in the polymerization tunnel-like chamber.
Polymer composite reinforcement consists of two main components: glass (basaltic) filament and polymer (epoxide) matrix. Fiberglass (basalt fiber) is the strength reinforcing element, which provides rebar durability, and the plastic binder provides composite action of elementary fiber.
This rebar technology was developed as far back as 70s in USSR. Today the technology itself is freely available. In the matter of principle composite rebar production looks the following way: fiberglass filaments are necessary to be soaked with resin, compressed in a filament tow, fastened with winding filament, let it harden in the furnace, cool down and cut off, in this case rebar movement is made by means of motive power. The task of developers and equipment constructors is to realise this technology so that there will be quality products with high tensile properties. There are many nuances and secrets in the very realization of this simple technology, so that the market is full of different offers. Equipment development for fibre-reinforced plastic rebar requires high technical skills as well as technological experience.

RAW MATERIALS.
Raw materials which are used for rebar production are: rebar base - fiber glass filament or basaltic filament (roving in bobbins with internal unwinding), winding filament for development of rebar -basaltic or fiberglass filament on coils with external unwinding, binder – three-component epoxide compound (epoxide resin, hardening compound IMTGFA - isomethyltetrahydrophthalic anhydride and UP – our self-developed accelerator/catalyst of amine type) and four-component epoxide compound (epoxide resin, hardening compound IMTGFA, alcofen, DEG-1).

PRODUCTION LINE PERFORMANCE CAPABILITIES.
There are rebars from 4 mm to 32 mm included, with spacing of 2 mm (standard diameters) which can be made on the production line, production output can be performed for rebars of any length (standart lengths are 6 metres and 12 metres), or in coils (4, 6 mm in coils with diameter of 1 meter, 8 mm in coils with diameter of 1,0-1,2 metres, 10 mm in coils with diameter of 1,0-1,2 metres, 10 mm in coils with diameter of 1,2-1,6 metres), winding operation is performed by means of coil winding machine.

TECHNOLOGICAL PROCESS DESCRIPTION.
On reel stands in the process of internal unwinding of bobbins with fiberglass roving (basaltic roving) through the slide-rails system a certain amount of filaments is conveyed (depending on fiberglass roving brand (basaltic roving) and rebar diameter) to the heating mechanism (this mechanism heats up and dehumidifies roving for more qualified polymer impregnation).
After heating fiberglass filaments get to the polymer binder impregnation mechanism where they are evenly divided, impregnated and afterwards removal of polymer excesses is made (by means of pressing system).
Fiberglass filaments, impregnated with polymer, get to the shape-generating mechanism (of a certain size for each rebar diameter). Before going through the shape-generating mechanism all the filaments are densely tightened by means of winding-supply mechanism (rebar forming mechanism with a built-in winding filament torsion mechanism) with twisted filaments (the amount of winding filaments can vary from 2 to 4, depending on the quantity of winding bobbins) with a certain (programmatically set up) spacing into a single periodically-expressed rebar.
Afterwards the unhardened bar gets into the tunnel hardening oven, where right in the process of hardening polymer is being smoothly heated up and is hardened.
After the tunnel oven the bar gets through the chilling mechanism, where it is cooled down by contacting with water to lower temperature. Rebar broaching is made by pulling mechanism. After the pulling mechanism, automatic mechanism makes length measurements and cuts off rebar. Receiving skid for finished products is set up after cutting-off mechanism, where packing and marking of finished products are made.

FIBRE-REINFORCED PLASTIC REBAR PROPERTIES AND USE.
- Chemical and corrosion resistance. Highly water-, alkaline- and acid-resistant. It refers to the 1st chemical-resistant group. By this, longevity and impossibility of cracking and destruction of reinforced concrete constructions in consequence of internal stresses, – which are caused in the process of corrosion and “growth” of concrete, as in the cases with steel reinforcement, – is guaranteed.
- Low thermal conductivity compared with metal. Thermal conductivity of composite materials on the basis of fiberglass is 10 times lower than metal thermal conductivity.
Consequently fibre-reinforced plastic rebar, in contrast to the steel one, is not a cold joint in a reinforced concrete construction.
- Thermal expansion coefficient is the same as of concrete one which excludes reinforcing breakage and crack formation in the concrete layer due to temperature gradients.
- Dielectrical (electrically non-conductive).
- Lower density and, consequently, 3.5 – 4 times less weighty, than a steel one.
- With the same diameter and 10 times leighter while using the diameter, equal in strength.
- Cheaper than a steel one at the expense of possibility to use minor diameter.
- With the same strength (of equally efficient diameter).
1. General view of the line.

2. Impregnating device.

Impregnating device is intended for evaporation of the lubricant, by impregnating glass material with resin, pressed binder and directions to the wrapping machine. It serves for impregnation of rovings with epoxide compounds, has a drum, which is set in motion by means of fiber movement though the impregnation bath.

The epoxide compound, located on the impregnation bath tray, goes up by beans of drum rotation, adhering to the surface of drum by means of its viscosity. In such a manner, the compound constantly goes though fibers of the filaments incoming in the area of fiber adhesion to the drum.

It provides not only impregnation of fibers with the compound but constant intermixing of the compound in the impregnation bath, too, which leads to more even distribution of component elements in bulk. Also this effect results in the even temperature regulation of the compound.

Binder extraction is performed by means of polyurethane base tightness at a certain angle and under a certain pressure towards the sufrace of drum. This method is the most effective for extracting comound from fibers since extraction is going on between the moving surface of the drum (moves simultaneously with fibers, plays a role of supporting unit) and the static knife edge. In this case, not doing harm to fibers of filaments, it is possible to apply pretty enough pressure on the knife in the area of its contact with fibers and the surface of the drum, having removed all the excesses of the epoxide compound out of fibers.

Press rating adjustment is made by means of changing air pressure in pneumatic cylinders, which press the knife to the drum. By means of elastic properties of polyurethane knife nodal crossing of fibers is provided, which are formed when the operator connects fiber edges of two bobbins, thus providing continuance of fiberglass roving supply.

Filament tension system with adjustment provides tension of rebar longitudinal fibers in the process of polymerization, making higher density of the bar being produced.
3. Wrapping machine/Rebar development mechanism (RDM).
Wrapping machine is designed for formation of glass material filaments into a tow and winding the filament in a spiral around the beam to create corrugated surface of the product.
4. **Heat-treatment chamber/ Polymerization tunnel-like chamber**

Heat-treatment chamber is for binder polymerization with roving and creating the product. Polymerization chamber serves for heating-up binding components in a formed rebar to specified temperatures.

The line consists of a polymerization chamber, which comprises five sections working independently. Each section is divided into two separate independently adjusted temperature loops. Temperature control in each of the loops is carried out by means of temperature controllers with PID control and thermocouples.

In such a manner this construction has 10 temperature areas, which allows to put a necessary time-temperature chart very accurately for every diameter of a bar produced.
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5. **Cooling chamber.**

Cooling bath is designed for a constant decrease of rebar temperature, which goes out of polymerization chambers. Water temperature is always of the same certain temperature limits so that there is no sharp temperature shock in order to provide continuity of the products manufactured.
6. **Main drive gear/ Pulling mechanism.**

Pulling mechanism serves for pulling a polymerized rebar with a specified speed and hold-down pressure value.

Since in the process of production composite rebars being manufactured do not get 100% polymerized after the cooling bath, it means that they are vulnerable to cracks formation when there is excessive body compression carried out by pulling elements, it is necessary to provide the most gentle conditions when they are being pulled.

By means of a big contact surface optimum characteristics, considering rebar friction and polyurethane rolls, were successfully reached. It gave an opportunity to decrease compression force between pulling elements while saving necessary pulling characteristics of the pulling mechanism without frictional sliding.
7. **Cutting machine.**

Cutting machine automatically cuts ready rebar to the specified length.
General description for all lines

**Electricity (excluding ventilation)**
- power input of 20 kW, (380 V, 3 phase and 0);
- average power consumption with a single line 8-15 kW/h ;

**Water**
technical, drinking 60 liters, automatic water supply is optional;

**Ventilation**
local exhaust

**Placement requirements:**
- storage for raw materials – 30 sqm, heated and ventilated;
- room for binder components of raw materials preparation – 15 sq. m.;
- storage of finished products is at customer’s discretion;
- production facilities from the calculation of one line dimensions - length 12-20 meters, width - 0.8 meters.