EXPLOENERGY

PACKAGED EMULSION PLANT

ENERGETIC INNOVATION

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PACKAGED EMULSION PLANT

The JWL Series packaged emulsion production line contains all equipment necessary to produce packaged emulsion cartridges at standard rates of 2.4-12 metric tons per hour.

Other rates outside of this range are possible according to customer requirements. Cartridges may be produced in diameters of 25-150mm, and lengths of 160-485mm. The production line can be configured to suit requirements according to production rate, raw material inputs, and product formulations and is engineered to operate at peak levels of efficiency and safety. The production line includes explosion proof motors and wiring, stainless jacketed piping, custom stainless conveyor assemblies, and a PC-based control system utilizing the latest industrial automation technology from leading brands such as Siemens and Endress+Hauser. The sensor and control technology allow it to achieve accurate and consistent performance. Safety interlocks are in place to monitor critical parameters such as temperature, pressure, flow, level, and electrical current. In the event of an abnormal situation, the control system will take appropriate precautions and alert designated personnel.

Currently there are over 87 production lines installed, with another 9 in various stages of construction and commissioning.

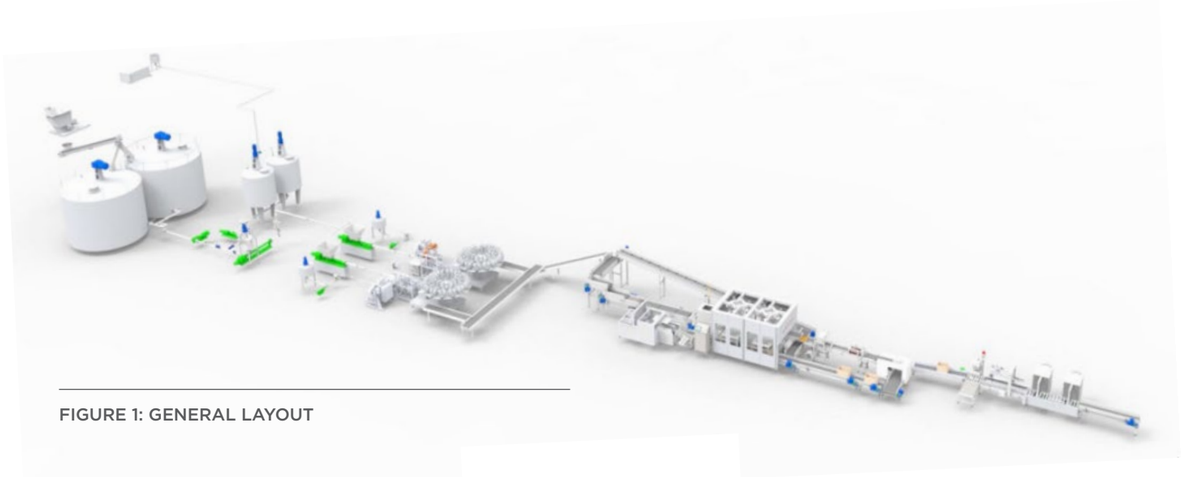


FIGURE 1: GENERAL LAYOUT

FIGURE 2: RAW MATERIAL PREPARATION

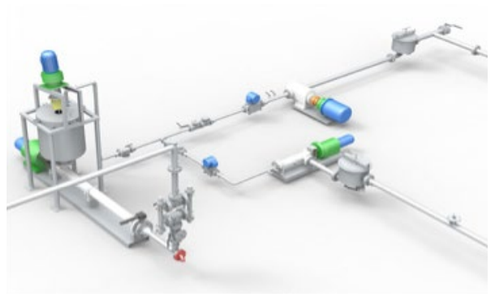
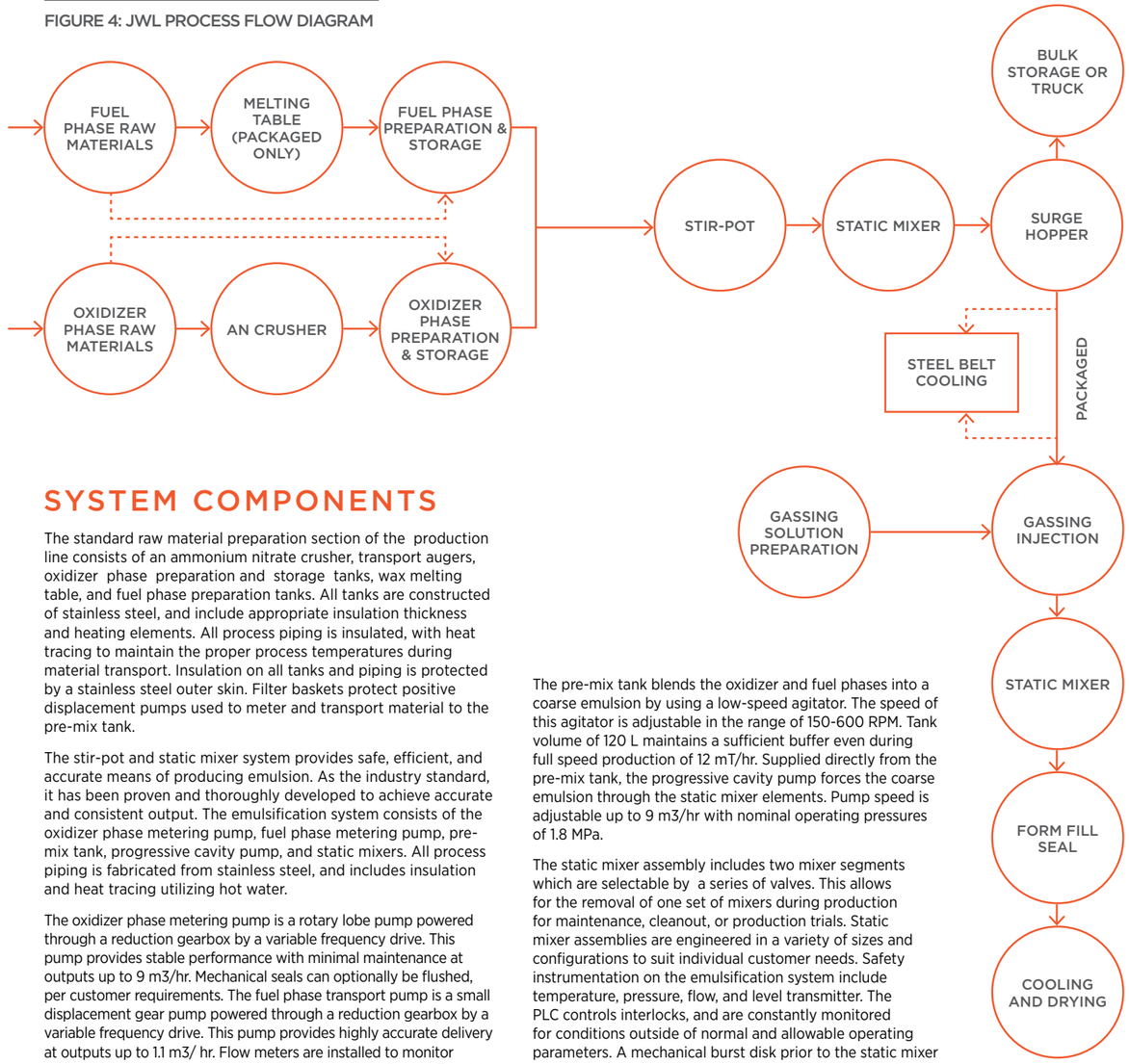


FIGURE 3: STIR POT STATIC MIXER SYSTEM

FIGURE 4: JWL PROCESS FLOW DIAGRAM



SYSTEM COMPONENTS

The standard raw material preparation section of the production line consists of an ammonium nitrate crusher, transport augers, oxidizer phase preparation and storage tanks, wax melting table, and fuel phase preparation tanks. All tanks are constructed of stainless steel, and include appropriate insulation thickness and heating elements. All process piping is insulated, with heat tracing to maintain the proper process temperatures during material transport. Insulation on all tanks and piping is protected by a stainless steel outer skin. Filter baskets protect positive displacement pumps used to meter and transport material to the pre-mix tank.

The stir-pot and static mixer system provides safe, efficient, and accurate means of producing emulsion. As the industry standard, it has been proven and thoroughly developed to achieve accurate and consistent output. The emulsification system consists of the oxidizer phase metering pump, fuel phase metering pump, pre-mix tank, progressive cavity pump, and static mixers. All process piping is fabricated from stainless steel, and includes insulation and heat tracing utilizing hot water.

The oxidizer phase metering pump is a rotary lobe pump powered through a reduction gearbox by a variable frequency drive. This pump provides stable performance with minimal maintenance at outputs up to 9 m3/hr. Mechanical seals can optionally be flushed, per customer requirements. The fuel phase transport pump is a small displacement gear pump powered through a reduction gearbox by a variable frequency drive. This pump provides highly accurate delivery at outputs up to 1.1 m3/ hr. Flow meters are installed to monitor oxidizer and fuel phase process flows and utilize the Coriolis Effect to precisely measure mass flow, and are able to calculate fluid density. These meters require no maintenance to maintain their high precision.

The pre-mix tank blends the oxidizer and fuel phases into a coarse emulsion by using a low-speed agitator. The speed of this agitator is adjustable in the range of 150-600 RPM. Tank volume of 120 L maintains a sufficient buffer even during full speed production of 12 mT/hr. Supplied directly from the pre-mix tank, the progressive cavity pump forces the coarse emulsion through the static mixer elements. Pump speed is adjustable up to 9 m3/hr with nominal operating pressures of 1.8 MPa.

The static mixer assembly includes two mixer segments which are selectable by a series of valves. This allows for the removal of one set of mixers during production for maintenance, cleanout, or production trials. Static mixer assemblies are engineered in a variety of sizes and configurations to suit individual customer needs. Safety instrumentation on the emulsification system include temperature, pressure, flow, and level transmitter. The PLC controls interlocks, and are constantly monitored for conditions outside of normal and allowable operating parameters. A mechanical burst disk prior to the static mixer assembly provides an additional level of protection in the event of electronic malfunction. All process instrumentation operates on low voltage/current supplies to minimize risk.

CARTRIDGING

The standard cartridging process includes chemical sensitization of the emulsion, and the form, fill, and seal processes. The cartridging pump feeds directly from the cartridging pump hopper, and moves emulsion through the gassing injection point, static dispersion assembly, and to the cartridging machine. This pump operates at up to 6 m3/hr with a nominal working pressure of 1.2 MPa.

Process safety includes temperature and pressure sensors, and a mechanical burst disk. The cartridging pump hopper is fully insulated, designed with a standard volume of 0.16 m3, and includes a temperature and level probe. The hopper creates a surge buffer and allows time to react to abnormal conditions without disrupting other areas of the production line.

Film splicing and tension control are handled by a roll-to-roll splicing unit capable of film changeover at full production line speed. This ensures consistent product quality and maximum efficiency by eliminating the need to slow or stop production to replenish the film supply. The two film strips are attached together, while a film take-up mechanism below provides the necessary film to maintain production.

The Rota-Clip RC-12 performs the form-fill-seal operation at high speed to match the emulsion production rate, and produces cartridges in diameters of 25-150 mm and lengths of 160-485 mm. An extruded glue seal is standard for forming the film into a strong casing. The tube is then filled, crimped with Tipper Tie clips, and released onto the conveyor system for cooling. The Rota-Clip unit is capable of production output in excess of 330 pcs/min.

FIGURE 5: CARTRIDGING SYSTEM

FIGURE 5A: AUTOMATIC FILM SPLICER

CARTRIDGE COOLING

Cartridges are cooled with a conventional water bath or by steel belt cooling. Operating at a nominal speed of 15 m/min, the cooling bath conveyors ensure that cartridges reach the desired temperature for product quality and safe handling. Separation distance between groups of cartridges may be closely controlled in order to minimize propagation in the event of an unplanned detonation. This safety feature groups cartridges together and allows bundles to proceed at set distance intervals, rather than allowing a continuous flow of cartridges along the conveyors. This system is easily adjusted via the PLC to meet safety regulations or requirements at the customer site.

OPTION A: HIGH TEMPERATURE GASSING WITH TRADITIONAL COOLING BATH

After packaging at high temperature, the cartridges are immediately transferred and cooled to control the gassing process. The cartridges pass through the cooling bath and under a blow drier to minimize moisture carried to the packaging area. Operating at a nominal speed of 15 m/min, the cooling bath conveyors carry the cartridges on multiple passes to reach the desired temperature for product quality and safe handling

OPTION B: MID TEMPERATURE GASSING WITH STEEL BELT COOLING

Unsensitized emulsion matrix is first cooled to an intermediate temperature (50 – 60 Celsius) via a thin-film steel belt cooling technique. A thin layer of emulsion is spread onto the upper surface of the steel belt while cooling water is sprayed onto the opposite belt surface. The steel belt provides uniform cooling of all emulsion in order to facilitate lower emulsion temperatures in the center of large diameter cartridges. Mid-temperature chemical gassing takes place immediately after steel belt cooling and prior to emulsion cartridging. Mid-temperature cartridges are immediately transferred to the secondary cooling bath for final cooling. The cartridges pass through the cooling bath and under a forced air drier to minimize moisture carried to the packaging area.

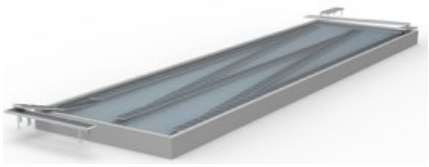


FIGURE 6: COOLING BAT

FIGURE 7: STEEL BELT COOLING

SENSITIZATION

Chemical gassing is employed as the primary method of emulsion sensitization. Mechanical blending units are also available for applications requiring the use of glass or plastic microspheres. Unsensitized emulsion matrix typically flows directly from the stir pot static mixer and into the cartridge pump hopper. Alternatively, mid-temperature gassing technology utilizes steel belt cooling equipment to partially cool the unsensitized emulsion matrix prior to the cartridge pump hopper and sensitization. The gassing solution dissolving tank uses an agitator to ensure the mixture is completely mixed prior to injection. Standard tank volume is 0.2 m3. This gassing solution is injected into the process stream by a piston pump operating at 6-30 L/hr, and the flow is monitored for consistency. A mechanical pressure relief protects the pump from damage. Emulsion and gassing solution pass through a static dispersion assembly which evenly disperses the gassing solution for optimum product quality and process safety.

Chemical gassing may be performed when emulsion temperatures lie within the range of 45 – 85 Celsius. The temperature at which gassing takes place is dependent upon the cooling and gassing technologies that are employed. King Explorer offers multiple emulsion/cartridge cooling options and can also supply the necessary chemical gassing know-how to ensure proper performance of the finished emulsion cartridges. Please review the “Cartridge Cooling” section of this document for further information.

MGEPL-R HIGH SPEED ROBOTIC PACKAGING LINE

The MGEPL-R is a highly automated robotic packaging system capable of production rates in excess of 10 metric tonnes per hour. Without the requirement for stationary operating personnel, the system intelligently picks and packages cartridges of varying dimensions. The MGEPL-R can be configured to handle cartridges of diameters ranging from 25-150 millimeters, and is easily changed over to accommodate varying production requirements on a single line. A complete track and trace system is available with cartridge, inner packing, and carton printing capabilities. High production capacity is achieved while minimizing noise generation and energy consumption. The MGEPL-R system is designed to work well as part of the JWL production line or may be separately purchased for integration into existing production lines.

FIGURE 8: MGEPL-R PACKAGING SYSTEM

CONTROL SYSTEM

The JWL-RMA production monitoring system integrates features found in leading MRP (manufacturing resource planning) and SCADA (supervisory control and data acquisition) software, while customizing the features and functions to the civil explosive production industry. This software package enables monitoring of the production, inventory, and safety compliance of production facilities. HD video monitoring and recording is also supported, and video streams can be viewed remotely via the internet or VPN (virtual private network).

Integrated into the JWL-RMA software is the EMS (Equipment Management System) module. The EMS module handles the equipment maintenance, troubleshooting, and spare parts inventory. By gathering data specific to each equipment configuration and performing complex statistical analysis, maintenance intervals and procedures can be modified to save cost and minimize equipment down-time. The EMS module can be implemented as a standalone software package, separate from the JWL-RMA system.

SYSTEM SAFETY

Two conveyors located just after the cartridging machine and prior to final packaging are configured to create protection against propagation by use of a blocking plate. The up and down action of the blocking plate organizes cartridges into isolated bundles. The safety gap created between cartridge bundles acts as an in-situ detonation trap designed to arrest propagation of an unplanned detonation.

SYSTEM UTILITIES

The values below are estimates. Actual utility requirements are dependent upon the final plant configuration.

POWER SUPPLY

The standard JWL-III system is designed to operate on a 380V/3Φ/50Hz power supply. The system can be customized to operate on many different voltage/ frequency combinations to suit customer requirements. Energy consumption varies from 80kW to 160kW, depending on the system configuration and packaging rate.

STEAM SUPPLY

Nominal steam consumption is 2 mT/hr at 0.4 MPa.

COMPRESSED AIR SUPPLY

Nominal compressed air consumption is in the range of 6 m3/min at 0.7 MP

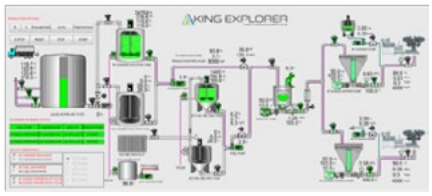


FIGURE 9: CONTROL SYSTEM