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Design and Development of new technologies in the gas processing industry

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The experts at Amin Fanavar Sharif started working in the field of processes and equipment related to the cryogenic industry about 10 years ago. Besides obtaining the technology of helium and liquefied natural gas (LNG) production, the technical knowledge of designing and manufacturing bottleneck equipment in this field, such as high-efficiency turboexpanders operating at high speeds, cold box heat exchangers, and helium gas purifiers has also been achieved. In August 2022, the First Vice President, Dr. Mokhber, inaugurated the helium and LNG production pilot plant built by this company

The technical departments of this company are:

- Control and instrumentation department
- Process Engineering department
- Rotary equipment engineering department
- Fixed equipment engineering department
- HSE department
- QC department

Each of these departments, benefiting from the knowledge of the renowned professors and top graduates of the Sharif University of Technology as well as seeking advice from the authentic experts of the oil and gas industry, has its path in the field of designing processes and cryogenic equipment based on international oil and gas standards and currently can design, manufacture, and commissioning of cryogenic complexes.

Some of the achievements in this Company are:

- The process design of cryogenic complexes
- Designing and manufacturing of cryogenic equipment according to the needs and specifications of the industry
- Design and implementation of instrumentation as well as centralized/ extensive control systemsystem and implementation of precision instruments
- Development of software used for designing and analyzing equipment and super cold processes
- Design and construction of super cold equipment test setup

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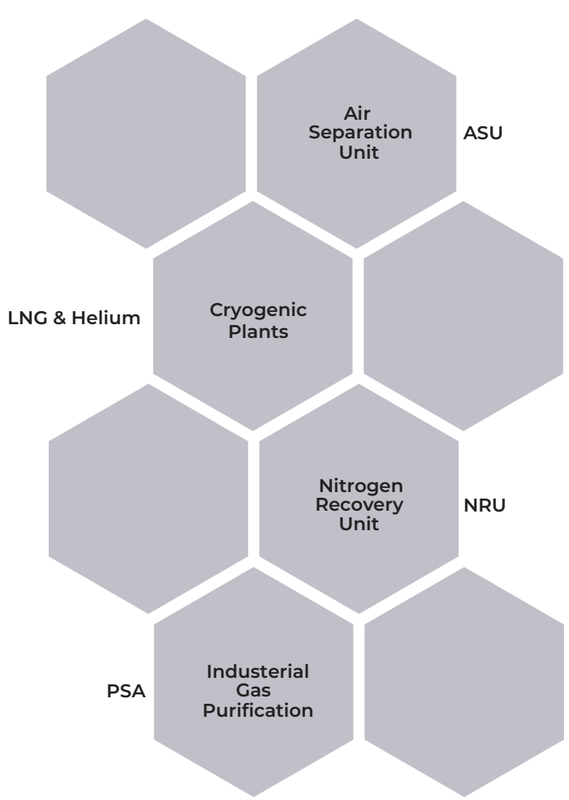
Process Engineering

Process design is the connection link of desired characteristics of an industrial process unit with its constituent parts. Therefore, process engineering is defined as a collection of knowledge necessary for the design, analysis, development, construction, and optimal utilization of industrial processes. In other words, process design is the backbone of designing industrial units in the oil, gas, and petrochemical industries to achieve the desired products.
By creating an integrated design management system among different units, the process engineering unit can organize the design constraints and technical requirements of different equipment in such a way that the cost, risk, and project time of the completed design is reduced.
Among the different processes in the oil and gas industry, super-cold (cryogenic) refrigeration processes are one of the most complex processes which require high costs and energy consumption in cooling cycles. One of the important challenges of this process is to minimize the total energy consumption.
Currently, the process team can acquire the following achievements in the field of cryogenic process design by evaluating different technologies, optimizing the design, and conducting field tests:

- Design, construction, and commissioning the first LNG and crude Helium gas production plant with a capacity of 5 tons per day
- Designing, manufacturing, and implementing a helium purification unit to produce helium with 99.999% purity.
- Providing a technical and financial feasibility platform with the ability to be used in other similar processes in the oil and gas industry.

Currently, the experts in this unit, with the knowledge of process engineering in different aspects, can design a cryogenic complex and design, reverse engineering, and promote various processes in the cryogenic field.

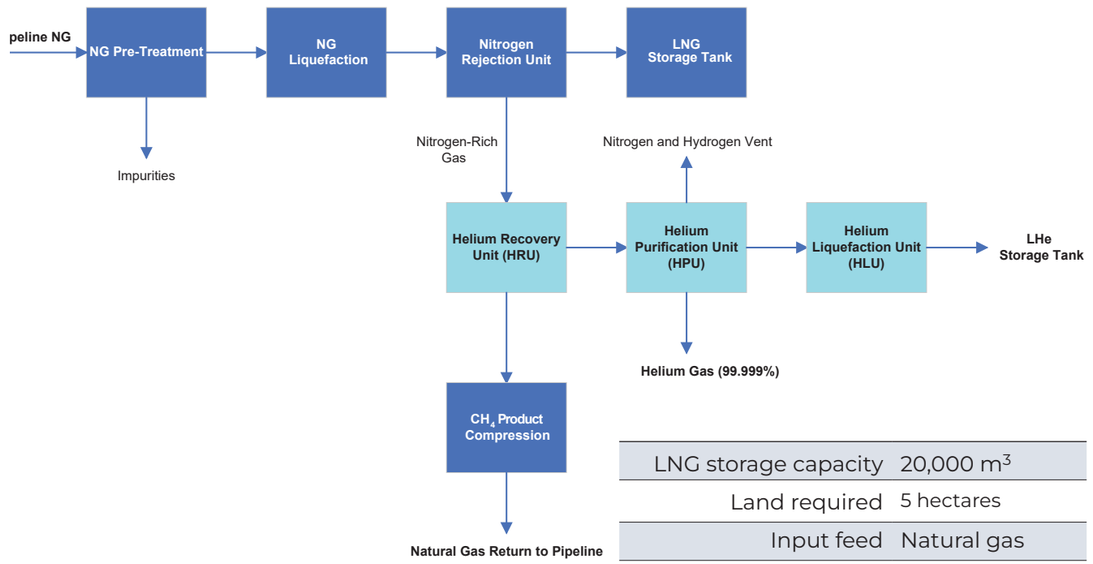


Liquefied Natural Gas (LNG) production Plant

Liquefied natural gas (LNG) is considered one of the primary energy carriers in the world. Natural gas transportation is carried out in two ways: pipeline or LNG (in which the volume of gas reduces more than 600 times). Generally, LNG is an economical choice for gas transportation over long distances.
The technologies used in the design of large-scale LNG production complexes are based on super-cold (cryogenic) refrigeration methods. The experts of this company can minimize the costs and risks of constructing LNG production complexes using complex design and energy consumption algorithms. The produced LNG is stored and loaded in standard tanks at the end of the natural gas liquefaction process.
Storage of natural gas to compensate for the lack of fuel in the cold season (Peak Shaving), using it as a substitute for diesel fuel in trains, and exporting liquid natural gas to distant places are the most noteworthy application of natural gas liquefaction technology.

Natural gas peak shaving unit with a capacity of 50 tons per day

In 2022, this company, in line with its primary mission of acquiring the technical knowledge of designing and building LNG and helium production complexes, started to design, build, and operate an LNG production unit with a capacity of 5 tons per day based on international standards.
Based on the experience gained in the design and construction of LNG micro-plants with a capacity of 5 tons per day, this company has started designing an LNG production plant with a total capacity of 50 tons per day to store gas in hot seasons for high-energy consumption industrial sectors. The construction of this unit by the specifications mentioned in the table below can reduce the significant loss of the petrochemical and steelmaking industries in the cold seasons of the year to an acceptable level.



LNG storage capacity	20,000 m^3
Land required	5 hectares
Input feed	Natural gas
Natural gas liquefaction capacity	50 tons per day

Purification of industrial gases

The purification cycle of the helium gas converts the feed impure helium gas into pure helium gas using the combination mechanisms of PSA adsorber and cryogenic separator. The advanced technology of this equipment can purify helium up to grade 5 (99.999%), corresponding to all the needs of consumers. Significant decreases in helium supplying costs and providing higher operating power for helium-consuming systems are the most important advantages of using this cycle. All standards related to under pressure and low temperature equipment are considered in the design and construction of this cycle.

Technical Specifications

Capacity: 10-200 Nm^3/h
Maximum impurity level: 80%
Product: He (99.999%)
Working Pressure: 20-150 bar

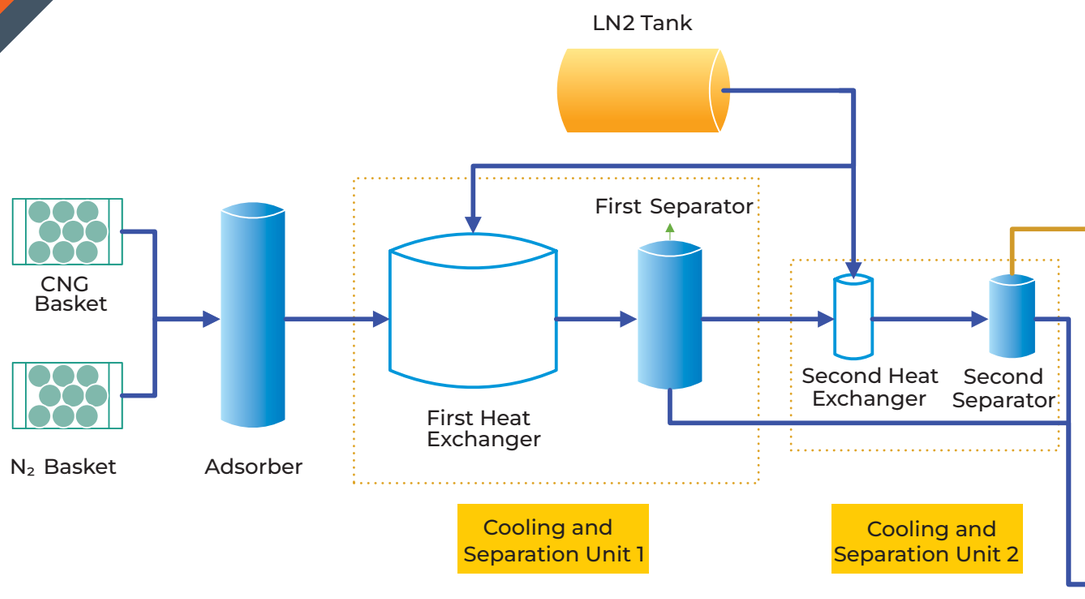
Applications:

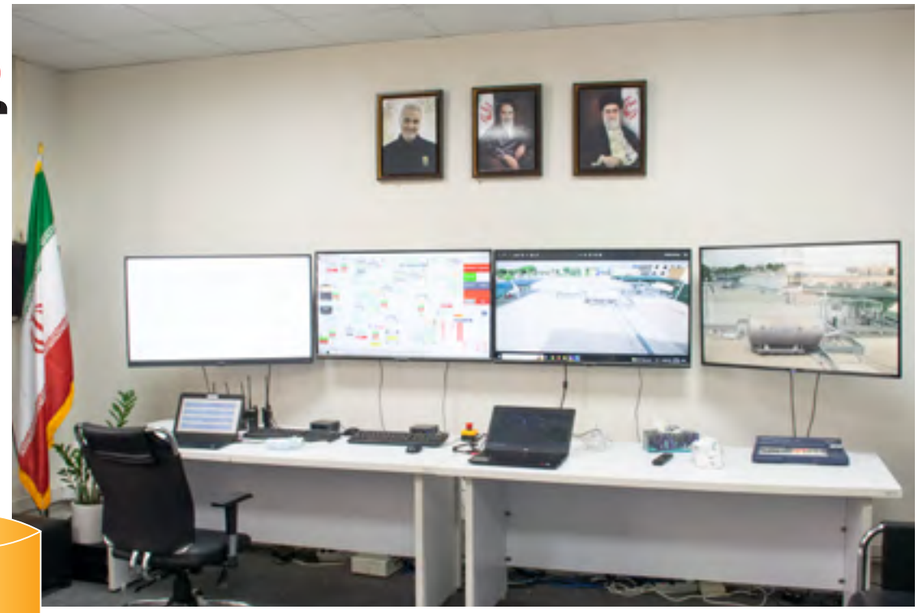
- Hospital MRI machine
- Weather Balloons
- GC Laboratories

Helium plant

Due to its unique properties, helium is considered one of the main infrastructures needed for advanced industries such as medicine, electronics, space, superconducting, computers with high computing power, etc.
Due to the non-reactivity of helium, it can create a neutral environment in welding. Since helium has the lowest boiling point among other materials (about -269 °C), it has also been used in cooling the magnetic core of superconductors in various industries, including MRI devices.
Other important applications of helium are the cleaning pipelines and sensitive equipment, leakage-detecting systems, and the production of electronic microchips. These wide applications of helium have caused it to be considered a strategic material. Natural gas reservoirs are the primary sources of helium gas in the world. For more than 15 years, Qatar started producing helium using the South Pars reservoir, which is the largest helium reservoir in the world, and currently supplies 30% of the world's helium demand.
The process of helium extraction from natural gas and its liquefaction is done using cryogenic, membrane, and absorption methods. The use of each of these methods is under the specific technical and economic conditions of each project. In this process, increasing helium purity takes place by removing other gas components. The experts at this company implemented advanced optimization algorithms and high-efficiency equipment for this process.
Plate-fin heat exchangers (cold box) with high efficiency and high-speed turbo-expanders capable of generating significant cooling by reducing pressure are among the main equipment of these processes.

The production chain of liquid helium from natural gas includes four main stages. In the first stage, impurities in the feed gas, including water, carbon dioxide, and sulfur-containing compounds removed using adsorption methods (gas pre-treatment stage). In the second stage, the concentration of helium increases using technologies based on cooling and refrigeration separation methods. In this stage, most heavy and light hydrocarbons remove from the gas stream, and a nitrogen- and helium-riched stream is achieved at the end of this stage.
In the next step, i.e., the purification step, other remaining materials including nitrogen and hydrogen are separated using a combination of refrigeration and adsorption methods, resulting in producing helium with very high purity. In the liquefaction stage, this gas is liquefied and stored in special tanks during a cryogenic refrigeration process. This process is designed in such a way that, if necessary, the customer can produce LNG as a by-product.





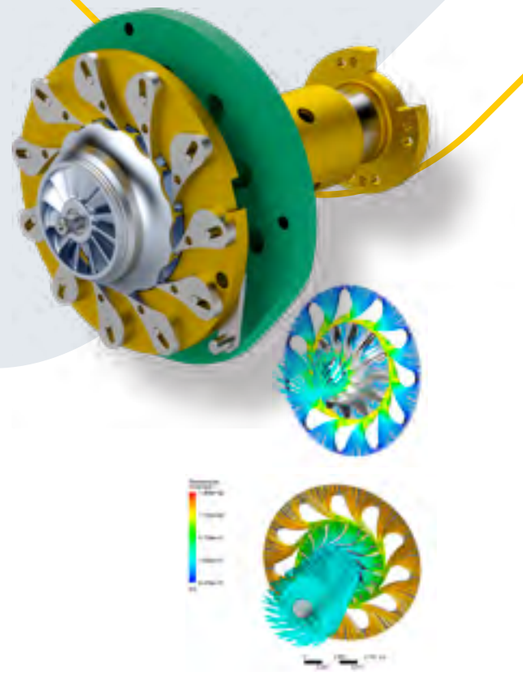
Crude Helium Production Pilot Plant

Achievements:

- LNG Production Technology
- Helium Extraction Technology
- Cryogenic Plant Process Design
- Cryogenic Equipment Design and Manufacturing
- Cryogenic Plant Piping Design and Construction
- Cryogenic Plant Control System Design
- Cryogenic Plant Commissioning and Operation Technology

Rotating Equipment

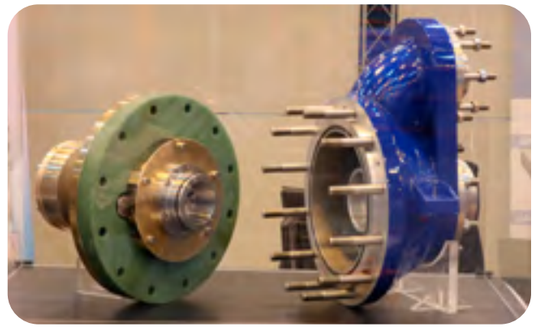
Turbo-Expander



Turboexpander is a type of radial turbine in that the flow with high pressure enters it in a radial form and loses its energy, resulting in decreasing its temperature and pressure. This equipment is used in cryogenic cycles to reduce the temperature significantly. The design and manufacturing of these turbines require complex technologies owing to the very high speed and low temperature.

Depending on the application, the power produced in these turbines may be used as the required energy to start the compressor, generator, pump, or energy generator in hydraulic brakes. The requirement for the design and construction of this equipment is to master the knowledge governing the behavior of rotor dynamic fluids and material science. Compliance with API 670, API 614, and API 617 standards is one of the design and manufacturing requirements.

The design knowledge development and construction of the complete turboexpander package were done in collaboration with Fars Afzar Kimia company. The technical knowledge of the design, construction, assembly, and commissioning of turboexpanders is available following international standards. This package consists of subsystems of lubricating oil, sealing gas, control system, and turboexpander set. It should be mentioned that the design process of all these subsystems was done by the experts at Amin Fanavar Sharif company. This turboexpander can also be used in the helium gas separation process.



Technical Specifications

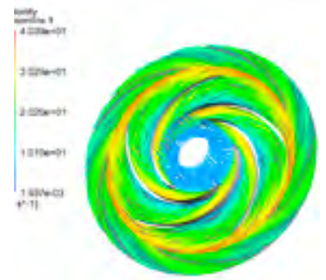
Speed	Up to 60,000 rpm
Capacity	3,000-10,000 Nm^3/h
Maximum pressure ratio	8
Maximum operating pressure	50 bars
Output temperature	-180 °C
Working fluid	CO, O2, N2

Applications

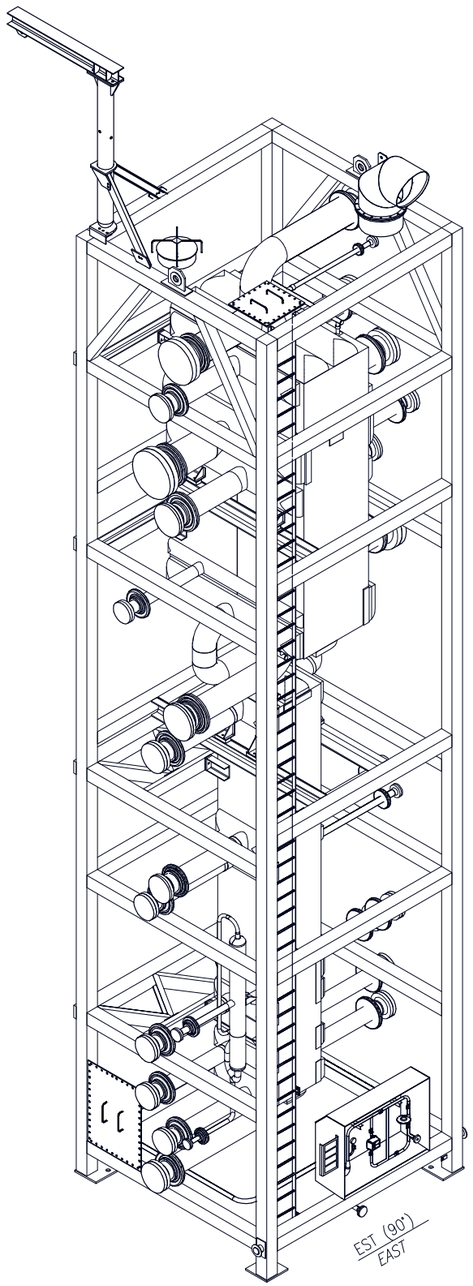
- Oil, gas, and petrochemical refineries
- ASU units of steel industries
- Pressure reduction stations

Pump

Pumps are the main fluid transfer equipment in the refinery, steel, copper, etc. industries. According to the intended performance, different types of centrifugal, reciprocating, and screw pumps are used in industries to transfer water, light and heavy oils, and cryogenic fluids including liquid oxygen, liquid nitrogen, liquid argon, liquid propane, liquid butane, etc. This company can design and manufacture all types of centrifugal and screw pumps according to the following table:



Pump Type	Technical Specifications
Centrifugal	• Single and multi-stage • Discharge pressure up to 40 bar • Head increase up to 350 m • Inlet NPSH 1.3m • Appropriate for cryogenic liquids like Oxygen, Nitrogen, Argon, Propane, and Butane. • Submerge and in-line
Screw	• Single and Multi-stage • Discharge pressure up to 240 bar • RPMs: 960, 1150, 1450, 1750, 2900, 3500 • Capacity: 49, 68, 97, 125, 236, 294 LPMs at 5.34bar and with lubricant viscosity of 43CST • Appropriate for light oil with 2 CST viscosity and heavy oils with 650 CST viscosity • Floating and in-line



Coldbox Plate Fin Heat Exchanger

Plate fin heat exchanger (Coldbox) is one of the most widely used equipment in cryogenic processes of oil, gas, and petrochemical industries. This heat exchanger has a high heat transfer capacity, especially at low temperatures. The design of this exchanger requires accurate analysis of fluid flow and material flow, and its manufacturing by vacuum brazing method requires high levels of knowledge and experience as well as special devices. The design and construction of these heat exchangers are based on ALPEMA and ASME SEC VIII standards.

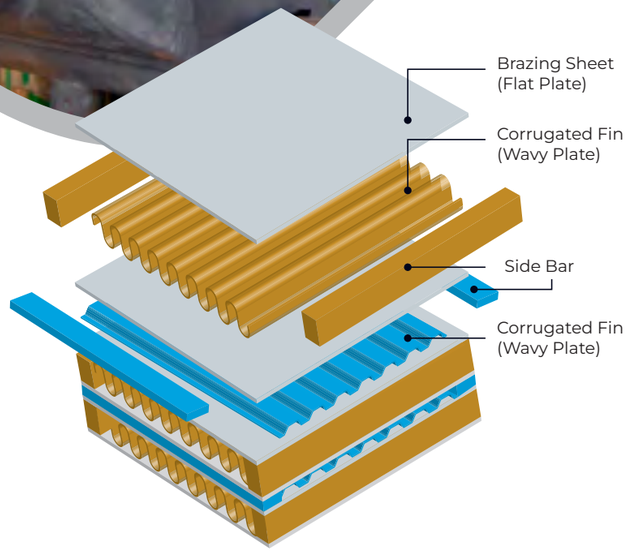
The performance of the heat exchangers, manufactured according to the design, is tested using the setup test of cold box heat exchangers at very low temperatures and high pressures. Also, the higher mechanical strength of the brazed section was verified by testing the mechanical strength of the brazed section at a much higher pressure than the working pressure.

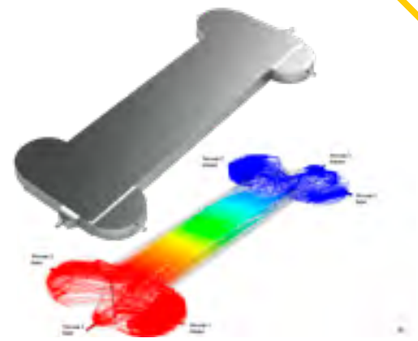
Technical specifications

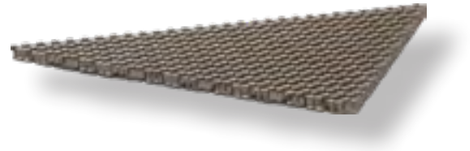
Minimum working temperature	-269 °C
Maximum working pressure	100 bars

Applications:

- Oil, gas, and petrochemical refineries
- ASU units of steel industries
- Gas liquefaction units

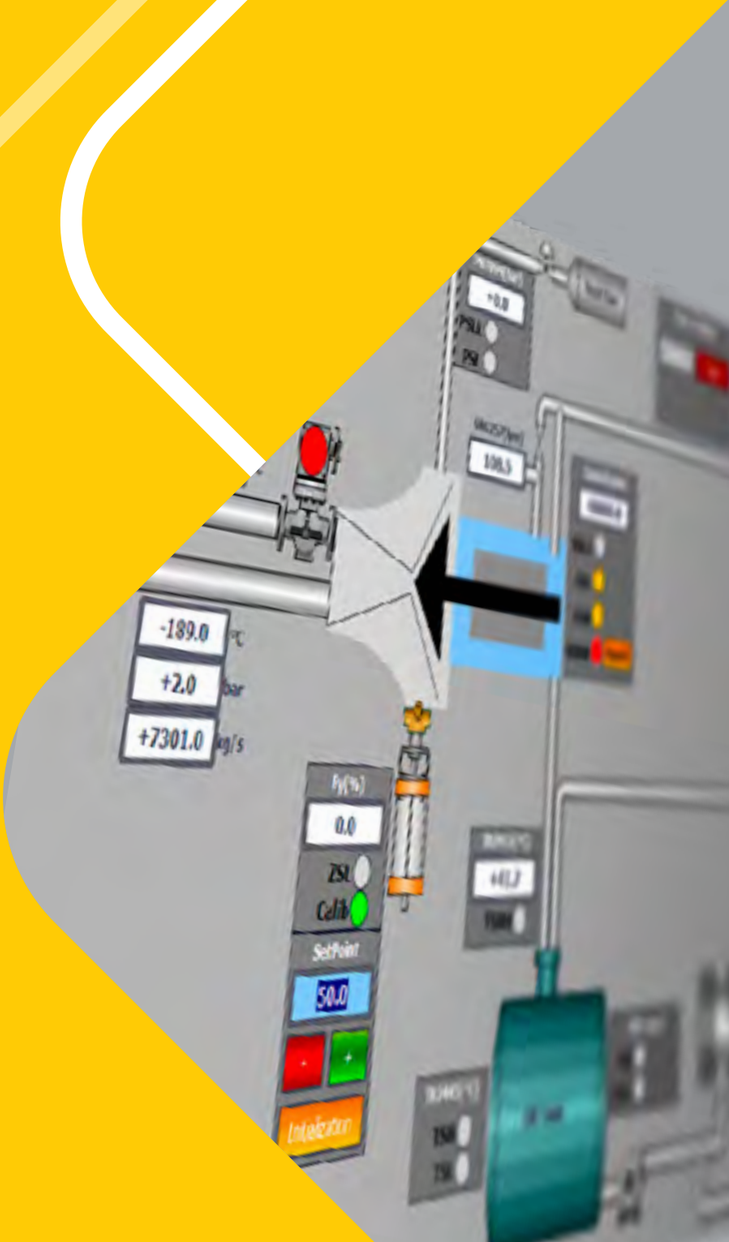






Design and Implementation of Control and Instrumentation System

Control and instrumentation is one of the most crucial units in the design of any industrial process which includes measuring, monitoring, and analyzing the process in order to achieve the desired product.
Process control is performed by utilizing instrumentations, actuators, and a programmable logic control system.
In the field of cryogenics though, implementing a control system requires taking specific measures and complying with strict constraints in choosing and utilizing control systems and instrumentations.
The control unit of this company can implement the control system and instrumentations of cryogenic processes, which may vary depending on the process demand, by utilizing the most up-to-date software and complying with special protocols and has achieved valuable experience in recent years. One of notable features of the units is performing the design and implementation of a broad range of control systems including centralized control systems in rotary machines and Distributed Control Systems (DCS) for process cycles. Furthermore, the engineers of this control unit could also implement various brands of control systems such as: Siemens, Beckhoff, Delta, Atech, etc for different processes



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