



# COMPRESSED NATURAL GAS STATIONS (CNGS)

(technical description)



## Application

Compressed natural gas station (CNGS) is intended for natural gas compression (methane) to pressure 250 kgf/cm<sup>2</sup>, its dehydration, cleaning from mechanical parts and further refueling to the cylinders of cars, small-capacity river and sea crafts and diesel locomotives of low and medium power.

### 1 CNGS Description

1.1 CNGS consists of the following basic components:

1.1.1 Reciprocal opposite compressor of Ariel Corporation manufacture, USA, with power drive.

Compressor and engine are assembled on one frame.

1.1.2 Air cooling block, intended for interstaged cooling of compressed gas.

1.1.3 Gas treatment module, that consists of input and interstaged separators, purge container, piping, stop and relief valves.

1.1.4 Module of input taps, which consists of piping, stop and relief valves.

1.1.5 Dryer, intended for dehydration and cleaning running to the consumer compressed natural gas to certified conditions.

1.1.6 Drain capacity, intended for condensate gathering produced in the process of gas liquefying.

1.1.7 Module of technological and emergency gas vents.

1.1.8 Battery module, intended for generation of compressed gas reserve with the purpose of its use for refueling vehicles both with operating and out-of-operation compressor.

1.2 The integral part of CNGS equipment – compressor with engine, gas treatment module, purge container, dryer – are assembled inside. Module of input taps, drain capacity, air cooling block, gas vents and battery module are installed outside the compressor house.

1.3 The CNGS equipment is assembled on separate bases and interconnected by means of technological piping.

It is possible to place compressor system, air-cooling apparatus, gas treatment module, purge container and dryer on the one frame.

Supply in block container version is also possible.

1.4 “Ariel” Corporation, with the products of which we complete CNGS of our manufacture, developed a series of compressors on various performances and suction pressures. So we can meet any need of the customer of stations according to these parameters.

1.4.1 Technical data of “Ariel” Corporation compressors:

– working substance	— natural gas
– flow, Nm <sup>3</sup> /h	— from 500 to 2500 (on customer’s request)
– suction pressure, kgf/cm <sup>2</sup>	— from 1,5 to 70 (on customer’s request)
– discharge pressure, kgf/cm <sup>2</sup>	— 250
– gas suction temperature, °C	— -30 – +45
– power consumption, kW	— according to compressor performance
– crankshaft speed, rpm	— 1500
– trouble-free life, hour, no less	— 4000
– assigned resource, hour, no less	— 150000

1.4.2 Engine is mounted on the same frame with a compressor and connected with it by means of a flexible coupling. Compressor start is realized smoothly by gradual increase in revolutions of an engine.

On customer’s request smooth adjustment of engine operating speed can be realized within the limits from 700 to 1500 rpm.

**Compressor and engine control is realized from the operator’s room, located in the near-by building.**

1.4.3 Compressor oil system consists of a gear pump for the crankshaft and connecting rods lubrication, lubricator of cylinders and gaskets, as well as force-feed lubricator pump. Oil cooling – air.

1.4.4 Buffer capacities are provided for leveling the compressed gas on each compressor discharge stage.

1.4.5 In the process of compressor operation pressure and temperature of the compressed gas are under control on each stage. Compressor is protected from pressure increase by pressure-relief valves, installed at discharge line after each stage of compression. As a protection from reverse compressed gas flow check valves are provided.



1.5 Input separator is intended for cleaning of the discharged to the compressor gas from mechanical particles and moisture. It is a vertically installed container with wavelike nozzle and baffle nets, where the process of gas cleaning to the certified conditions takes place. Inlet gas undergoes thrice-repeated filtering.

1.6 Before discharging to the compressor gas enters fine filter with a hydrophobic filter element, where the mechanical impurities and moisture are eliminated.

1.7 After compression gas is directed to the air-cooling block (ACB), where its temperature drops to the calculated value. After ACB gas directs to separators, where condensate and oil are eliminated, that got there in the process of compression and cooling.

1.8 Interstaged separators are installed at discharge on each stage of the compressor and serve for separation of condensate, generated in gas after its compression on each stage of the compressor and cooling in ACB. They [separators] represent vertical containers, in upper part of which gas is discharged tangentially. Separation of condensate occurs due to centrifugal forces.

1.9 Purge container is intended for condensate gathering in the process of technological purging of CNGS equipment. Condensate, accumulating in a purge container, is discharged into drain capacity.

1.10 Air cooling block serves for interstaged cooling of compressed gas. It is made of ribbed bimetallic (steel + aluminum) pipes, gathered in sections. Cooling of pipes is realized by air, purging through fan sections.

1.11 Dryer consists of two throaty cylinders with silica gel (adsorbers), one of which works in drying of produced compressed gas, another at the same time is regenerated by reverse flow of heated low pressure gas. For gas heating (in the process of regeneration) energy saving technology is applied in the dryer: gas is heated in special heat exchangers by hot gas, discharging from one of the stages of compressor without energy consumption. Adsorbers are enclosed in a special heat-insulated casing.

1.12 Drain capacity represents a container  $V=0,75 \text{ m}^3$ , installed horizontally in a pit and covered with ground. It serves for gathering condensate and oil, separated from gas in the process of its compression. Little quantity of gas, entering a drain capacity, discharges to atmosphere through a stalk.

1.13 Module of technological and emergency gas vents is intended for discharging technological gas leaks into atmosphere, generating in the process of CNGS operation, and also all volume of gas in emergency situation, and represents a series of piping vertically installed on the basis, by means of piping connected with the equipment of station.

1.14 Battery module is a container that consists of cylinders, connected with common piping and placed in a common frame. Battery module, on customer's request, can be sized from  $1 \text{ m}^3$  to  $4 \text{ m}^3$ .

1.15 All the equipment and piping of CNGS are tested on strength and hermiticity with the appropriate pressure at a manufacturing plant. Crucial components – compressor and engine – are subjected to the check test after assembling.

1.16 Manufacturing scheme of CNGS realizes a system of automatic purging of oil separators and compressor unloading at start of a compressor.

1.17 CNGS control system provides control of all the necessary parameters of its operation (pressure and temperature of the gas being compressed and compressor lubricating oil) as well as its shutoff in an emergency situation.

CNGS and fueling manifold have overpressure protection.

1.18 On customer's request CNGS can be packaged with one- or two-operator dispensers. Dispensers have overpressure protection of a refueling, on reaching minimum speed of refueling, on departure of car with unconnected hose.

Dispensers KZM-200 (method of variable pressure-drop) and KZMK-200 (mass flowmeter) are intended for refuelling of vehicles with compressed natural gas according to GOST 27577, measurement of volume and mass of refueled gas, and also for fixing the price of refueled gas.

Dispenser consists of:

- post;
- flowmeter;
- refueling unit;
- display unit;
- calculator.

Technical data

- |   |   |             |
|---|---|-------------|
| – maximum working pressure, $\text{kgf/cm}^2$ | — | 250         |
| – limits of allowable relative error          | — | $\pm 1,0\%$ |
| – power consumption, V·A, no more             | — | 60          |



## AUTOMATIC CONTROL SYSTEM (ACS) CNGS

### 1. General data of the system.

#### 1.1 Structure and functioning.

Automatic control system of CNGS is centralized and performed on the basis of software and hardware tools of SIMATIC S7-300 type.

ACS is based on a hierarchical approach:

- a) lower level:
  - sensors of pressure, temperature, gas contamination and fire; also sensors of stop valves position and magnetic starters of electric drives (input analog and discrete signals);
  - audio alarm device, magnetic starters of electric drives (receivers of output signals);
- б) upper level:
  - control panel – on the basis of software and hardware tools of SIMATIC S7-300 type.
  - power panel, where power switchgear is placed.
  - operation's station on the basis of personal computer.

Connection between the components of the system is realized by physical and interface channels.

#### 1.2 Factors of application.

ACS provides:

- a) trouble-free operation of technological equipment of CNGS on all modes of its operation, without full time presence of operating personnel in a place of equipment location;
- б) reliable information of maintenance staff about the course of technological process, both at the real-time mode and by archives kept in the memory of controller;
- в) interaction by physical links with gas contamination control and fire detection devices.

#### 1.3 Reliability of ACS.

ACS is a multichannel, multifunctional durable system and repairable object with periodical maintenance. Average trouble-free life of ACS (failures of sensors and actuating mechanisms are not considered) under normal conditions of operation of "Failure ignore" type is no less than 100000 hours.

Control of life ratios is done by processing of statistic data, obtained from the operating conditions.

Average life time of ACS is no less than 20 years.

#### 1.4 Integrity of information and its protection from unauthorized access.

To analyze the condition of CNGS technological equipment, to clarify and analyze the reasons of emergency situations ACS provides forming of the following archives:

- a) archive of technological process parameters, that consists of archival values of controllable parameters: analog and discrete sensors, position-indicating signals of actuating mechanisms.
- б) events archive, that on all modes compiles discrete information with restore time for each event: emergency and caution signals, reports on hardware failures and failures to execute the commands, control commands of actuating mechanisms, modes of CNGS operation, operating and controlling commands of an operator (with commitment of date, time and statement identifier). Registration of an operator in ACS is realized at change of shifts.

Retrospective information compiles for the period of registration with cyclicity no more than 0,1s and is kept in nonvolatile memory with duration:

- parameters archive and events archive – up to 6 months;
- shift list – up to 12 months.

Retrospective information is displayed both in a chart view and as a graph of parameter changing for the required period (with scaling), with a possibility of its value control in any place of period in a digital view.

ACS has unauthorized access protection to applied software (on customer's agreement).



## 1.5 Functions, performed by a system.

### Informative functions:

- a) continuous control of technological parameters, including measurement and displaying on the screen of a monitor values of indicated parameters in units of physical quantities;
- b) displaying on the screen of a monitor symbolic circuit of CNGS, with indication the position of actuating mechanisms and measurable parameters in places of control;
- c) automatic detection and displaying on monitor's screen the following events:
  - runaway of technological parameters from fixed limits,
  - failure to execute control commands,
  - Deviations in operation of ACS hardware;
- d) automatic continuous control of analog sensors' communication lines.  
Audio alarm should be taken off by an operator of an acknowledgment team.

### Functions of control:

- a) checking of CNGS readiness to start, automatic shift of stop valves into initial position before CNGS start, after choice of operating mode;
- b) automated CNGS start;
- c) automatic, normal and emergency CNGS shutdown – at actuation of protection or from operator's pushing the buttons;
- d) manual remote (from monitor's screen and control panel) control:
  - by a compressor module;
  - by stop valves;
- e) abort of operator's commands in the process of CNGS operation in automatic control mode, if they [commands] are not envisaged by computer algorithm.  
When the controller "hangs" blocks of exit instructions remember existing commands before controller failure.

### Protection functions:

- a) CNGS shutdown at deviations of controllable parameters higher and lower than allowable limits;
- b) CNGS shutdown at self-stopping and self-transposition of actuating mechanisms and failure to execute the control commands;
- c) CNGS shutdown at open faults of sensors' links, which signals are used in the process of forming of protections.

## 2 Support.

### ACS technical support.

ACS hardware includes:

- Control panel, which consists of:
  - a) set of hardware and software, that provides realization of controlling and informational functions, according to technical assignment;
  - b) converters of input and output analog and discrete signals with galvanic isolation of circuits;
  - c) gas contamination control sensor;
  - d) power modules of program-technical means and sensors;
  - e) terminal blocks for connection of external circuits.Note: Overall dimensions of blocks – no more than 800x600x2000mm.
- Operated station is based on the office computer.
- Control sensors of technological parameters, according to application A.
- Set of cables.
- Maintenance documentation on ACS.

### Software.

ACS software provides realization of controlling and informational functions, which consists of basic and applied software.

Basic ACS software of CNGS is Windows 2000, because applied software of the compressor module (Trace Mode) operates under control of this basic software. Software is fully installed and checked.



## Terms and conditions of supply

### **Delivery time**

Delivery time 90-120 days.

### **Terms of supply**

EXW «Ex-works» Sumy, Ukraine.

### **Warranty**

Warranty period — 12 months from the beginning of operation, but no more than 18 months from the time of its supply.

### **Payment**

Payment is made according to the terms and conditions of a contract.

### **Term of validity**

This offer is valid within 30 days.

ETC “Orion-D” provides full after-sales service of supplied CNGS, as well as technical maintenance and troubleshooting of compressors of “Ariel” Corporation with supply of spares within 3 days.