[Gas-fired isothermal humidifier]

1. **GENERAL**
    a. **DESCRIPTION**
        i. Air humidification apparatus for the production of aseptic steam, with gas burner technology, supplied with mains drinking water, demineralised or softened water.
    b. **WORK REQUIRED**
        i. Installation according to the manufacturer's specifications, performed by technical personnel validated by the manufacturer and holding a gas license [selected by the customer]
        ii. System commissioning performed by [manufacturer's technical personnel, or technical personnel authorised by the manufacturer, chosen by the customer]
    c. **DOCUMENTATION**
        i. Technical manual for installation, configuration and operation, complete with dimensions, technical specifications, operating principles and performance, water circuit and wiring diagrams, standards and specifications for safe installation, guide for commissioning and operation, diagnostics, list and identification of spare parts.
        ii. User manual with safety and operating instructions.
    d. **QUALITY:**
        i. CE
        ii. $_{C}ETL_{US}$ (UL standards)
        iii. TÜV PRODUCT SERVICE
        iv. AGA
        v. WaterMark
        vi. ISO 9001:2015 - ISO 14001:2015 - ISO 45001:2018 (manufacturer)

2. **PRODUCT**
    a. **[definition of the apparatus, technology]**
        i. Stand-alone isothermal humidifier with gas burner for the production of steam at atmospheric pressure using mains drinking water, demineralised or softened water.
        ii. The water is heated via a heat exchanger containing the burner combustion head, producing sterile steam
        iii. The apparatus must be able to operate with natural gas (G20 or G25) or LPG (G31); the initial configuration must be performed in the field by setting software parameters and without replacing any mechanical parts.
        iv. steam production, water drain and refill must be managed by the control program completely automatically according to actual feedwater conductivity, without the need for prior analysis or settings.
    b. **[general features and construction]**
        i. Painted steel supporting structure with separate sections for the water circuit and the electrical parts, front and side panels that can be removed for maintenance
        ii. electrical section with electrical panel including electrical components and electronic control
        iii. the steam production boiler must be built using AISI 304 stainless steel.
        iv. The heat exchanger immersed in the water must be thin AISI316L stainless steel with a minimum heat exchange efficiency of 94%.

v. The quantity of steam produced must be modulated continuously, with a minimum flow-rate not exceeding 25%
vi. The water level must be controlled by a suitable three-level sensor
vii. any excess foam on the surface of the water must be detected and managed by a suitable device inside the boiler. SOLUTIONS WITHOUT PROTECTION AGAINST EMISSION OF BOILING WATER ARE NOT PERMITTED. The same device must also act as an additional safety level sensor

c. [model capacities and variants]

i. minimum model capacities:
   - 45, 90, 150, 180, 300, 450 kg/h, with one, two or three immersed burners/heat exchangers
ii. Higher capacities can be achieved by connecting several units in an intelligent arrangement, with automatic backup function in the event of shutdown due to maintenance or an alarm. Rotation must be available to balance wear across multiple apparatuses.
iii. Models:
   - "INDOOR" for installation in an equipment room
   - "OUTDOOR" for installation also outdoors
iv. steam boiler:
   - parallelepiped shape with front cover that can be opened to remove scale, and removable top cover to access the heat exchanger
   - The boiler must have outer thermal insulation to limit heat loss

d. [feedwater and drain water]

i. The apparatus must be able to use the following types of feedwater:
   - mains drinking water with a conductivity up to 1500 µS/cm
   - demineralised water (reverse osmosis)
   - softened water
ii. feedwater via a double-check valve to prevent backward contamination
iii. water must be drained by means of a pump; on request, a drain tempering device must be available to limit the drain water temperature to 60°C

e. [power supply specifications]

i. 230 V single-phase 50 Hz; 115 V single phase 60 Hz power supplies must be available

f. [control, characteristics]

i. The apparatus must be managed completely automatically by an electronic microprocessor controller. Steam production must be modulated continuously according to the input signal.
ii. input signal from probe or external controller: 0-1 V, 0-10 V, 0-20 mA, 4-20 mA, ON/OFF contact, 0-135 Ohms, 135-10,000 Ohms, NTC.
iii. An external enabling input and at least 4 programmable relays are required for remote signalling of alarm status, production status, activation of the steam blower
iv. An input for a second "limit" humidity probe is required to CONTINUOUSLY MODULATE PRODUCTION based on the humidity downstream in the duct, in order to prevent condensation during temperature transients. A SIMPLE ON/OFF ENABLING INPUT BASED ON A THRESHOLD IS NOT ACCEPTABLE FOR THIS PURPOSE.
v. The minimum required control algorithms, which can be selected during installation, are: stand-alone with room probe, stand-alone with main probe + modulating limit probe, stand-alone with two probes (average); secondary with external proportional voltage or current signal, with external signal + local limit probe, ON/OFF from voltage-free contact, with NTC temperature probe for steam baths.

vi. The user interface must feature a colour touch screen graphic display for programming and monitoring unit status, the set and measured humidity level, steam production, current draw, water conductivity, parameters and alarms using text and icons
vii. the web server function must be available for connectivity to the local Ethernet network
viii. It must be connectable to other similar units in *main-secondary* i.e. "mirror" mode so as to extend capacity, including the "automatic backup" and "rotation" functions to distribute wear equally across several humidifiers operating in the system
ix. It must be connectable to multiple wireless probes to avoid wiring in critical installations; the probes can be assigned a weight for average measurements.
x. Initial configuration must be guided via wizard
xi. The following must be included: complete diagnostics, alarm log downloadable via USB port for diagnosis; messages for preventive maintenance
xii. It must include daily and weekly programming of operation with differentiated set points.
xiii. Water pre-heating function to reduce time to reach production (programmable pre-heating set point);
xiv. Automatic frost protection function for the water in the boiler (outdoor version).
xv. Automatic emptying of the boiler when the internal temperature approaches 0°C (32°F) (outdoor version).

g. [performance data]

i. relative humidity control accuracy must be +/- 3%.
ii. maximum flow-rate must be settable by parameter, with continuous production control between 25% and 100% of the maximum set capacity (12.5% for models with two burners).

h. [safety, savings and hygiene]

i. the burner must be a negative pressure premix model with double safety shutter for the gas and negative pressure sensor on the air intake
ii. the flame control board must comply with CE, TÜV DVGW, ETL, AGA standards
iii. the flue gas temperature must be monitored by means of a specific temperature sensor to detect combustion problems or the need to clean the heat exchanger
iv. In addition, the flue gas exhaust system must be equipped with a mechanical thermal circuit breaker with manual reset to detect overheating and interrupt operation independently of the electronic controller.
v. the apparatus must be equipped with a conductivity meter in the feedwater supply circuit and a suitable software algorithm to optimise water change and prevent corrosion based on actual water quality, allowing significant savings in water consumption. SOLUTIONS THAT ONLY ALLOW MANUAL SETTING OF WATER HARDNESS DURING INSTALLATION ARE NOT ACCEPTABLE, THE SYSTEM MUST BE SELF-ADAPTIVE.
vi. automatic water draining due to inactivity must be factory-set every 3 days by parameter, however can be modified in the field to comply with any local regulations, so as to avoid hygiene problems due to stagnant water.
vii. The device must be equipped with an automatic frost protection feature

i. [interfaces]

i. BACnet, Modbus, CAREL protocols for BMS and remote control via RS485 serial; BACnet and Modbus protocols over Ethernet. Without requiring external devices.
ii. USB for programming, updating, parameter duplication, diagnostic logs
iii. Ethernet port
iv. RS485 serial port

j. [accessories]: the following must be available:

i. steam delivery hoses, food safety certified quality, with embedded steel spiral to prevent choking, diameters 22, 30, 40 and 80 mm
ii. stainless steel duct steam distributors with diameters 22, 30 and 40 mm, lengths between 35 and 205 cm, flow-rates from 1 to 40 kg/h, with separate condensate drain

iii. in-room steam blowers
iv. 10 mm drain pipes for condensate and 40/50 mm for humidifier water
v. wide range of relative humidity and temperature sensors, duct and room models, ranges 10-90% rH or 0-100% rH, with current or voltage signal
vi. range of wireless sensors for installation in critical locations

k. The type of apparatus shall be the CAREL gaSteam

l. Approved manufacturers: Carel Industries SpA

3. EXECUTION

a. Installation in compliance with the manufacturer's specifications

b. Installation in compliance with applicable local laws and regulations

c. Water quality as per manufacturer's specifications, under the responsibility of the user