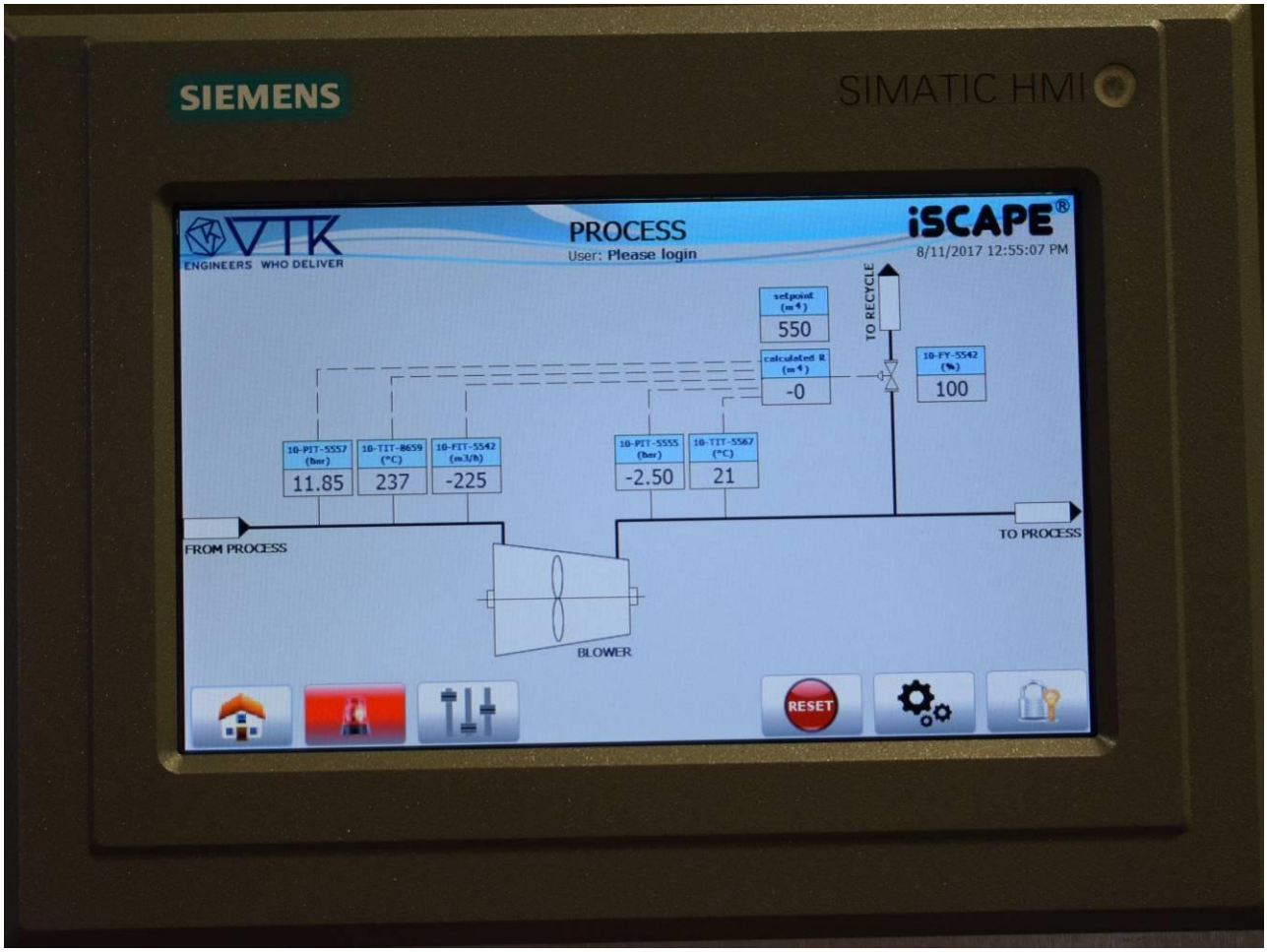
Van Tongeren kennemer bv
1948 RC Beverwijk
E-mail: info@VTK.nl
Phone+(31)251-229160

| Doc. No. | 16.0078-D. | Page: | COVER |
|---|---|---|---|
| Subject | : Installation, operation & maintenance instructions | | |
| Client | : Egyptian Chemical Industries (kima) | | |
| Client ref. no. | : | | |
| Project | : Start-Up blower | | |
| VTK ref. no. | : 16.0078 | | |

# INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS




Equipment : Anti Surge Controller

Equipment Tag : Not applicable

Project Title :

Location : Egypt

Client : Egyptian Chemical Industries (kina)

Client Ref. :

VTK Ref. : 16.0078

## INTERNAL VTK ONLY !!

## About this manual

This manual for control panels is drawn up in accordance with the requirements and recommendations ensuing from the CE directives.

The manual contains information on:

- Installation
- start-up and operation
- troubleshooting

**Start carrying out one of the above activities only after reading this manual carefully. Make sure that this manual is available for both management and executive staff.**

If the instructions as described here, are not followed up correctly, there is a risk of:

- endangering the safety of the executing staff
- endangering the proper operation of the control panel
- damage to the blower system

For questions or comments about the control panel, please contact VTK B.V.

Please do not hesitate to contact VTK B.V. they have the know-how, original parts, necessary tools and service department to help you quickly.

The following symbols and notations are used throughout this manual:

**NOTE**
Information bringing possible problems to your attention.



**CAUTION**
The control panel may be damaged, if instructions are not followed.

**WARNING**
Personnel may get (seriously) injured or (seriously) damage the control panel. Follow these instructions carefully.

**DANGER**
Lives of personnel are threatened.

**EXPLOSION PROTECTION**
Special instructions concerning explosion protection.

**INDEX**

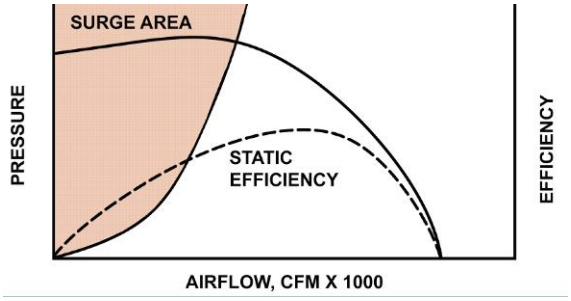
# 1 Product description

## 1.1 General description

This manual applies to a VTK B.V. anti-surge control panel.

## 1.2 What is surging

Backward curved fans at low gas flow will start surging. The direction of the gas flow inside a section of the impeller will momentarily reverse. The magnitude and direction of the present mechanical forces will shift and the fan housing and impeller will respond with vibration. When this situation continues to exist the fan, components will get damaged and or fatigued.



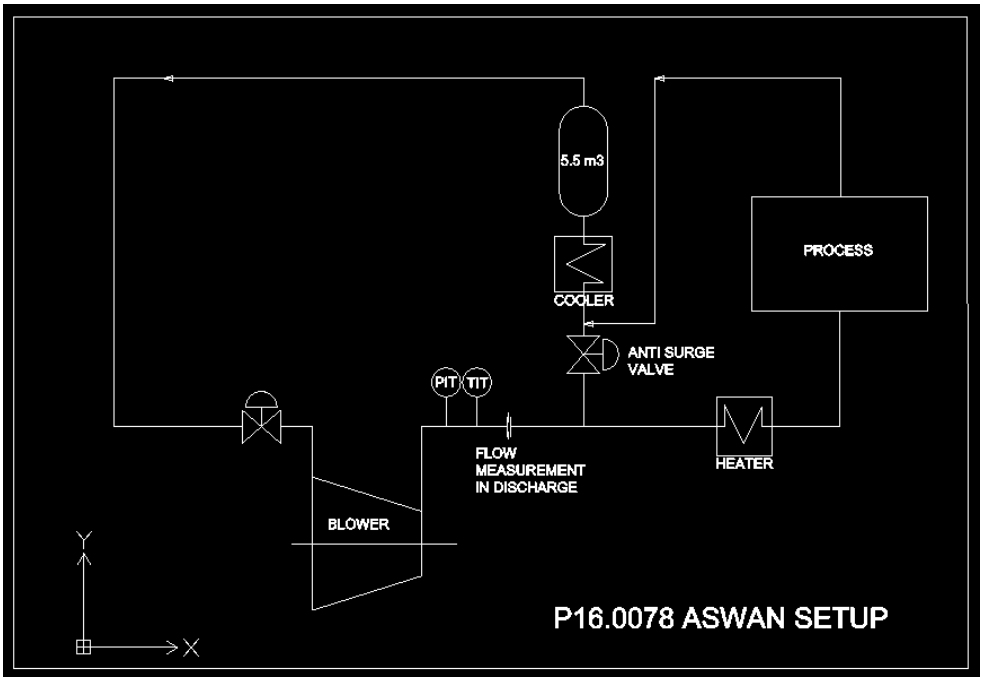

## 1.3 Surging symptoms

Surging does interrupt your process e.g. drying, heating, cooling or transporting.
Surging will cause a dramatic increase in noise and vibration this will in time result in structural fatigue damage to your fan . Bearing, main shaft, hub, impeller, coupling and motor life will be dramatically reduced and your fan process will be interrupted.

## 1.4 How does the ASC work?

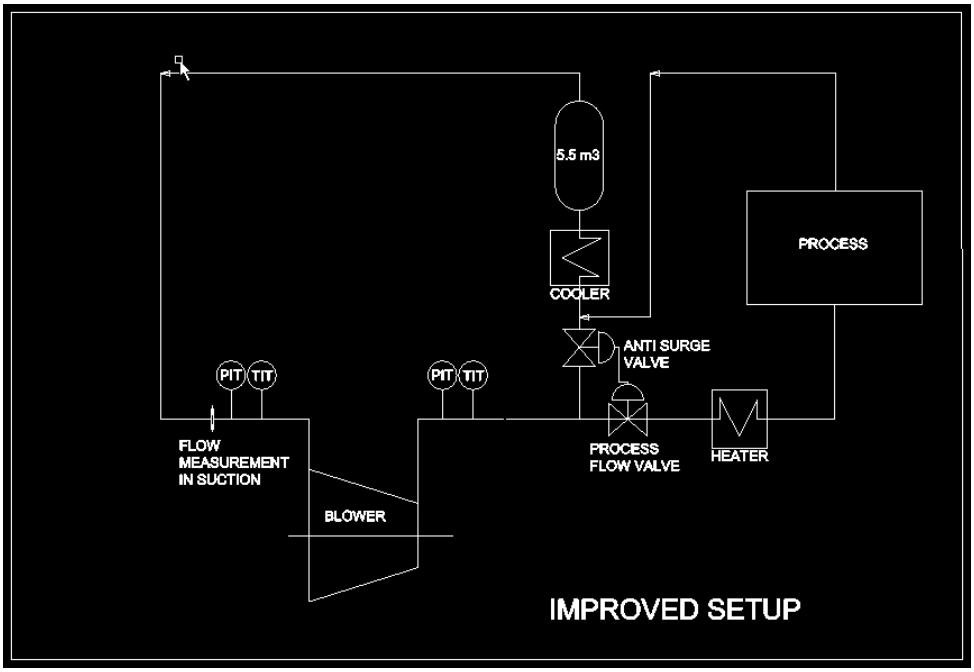
The air flow, pressure and temperature are measured, these conditions are converted to standard conditions and compared to the surge characteristics of the fan by an advanced algorithm. When the flow through the fan starts to reduce and reached a critical surge point the Anti Surge Controller will open a bypass or blow-off valve to ensure the minimum required flow. The fan is now protected and the process is not interrupted.
The PLC control algorithm not only calculates with the mentioned flow, pressures and temperatures but also takes the molecular weight and polytrophic exponent of the gas into account. The fan characteristics are also entered. All measured and calculated data is presented on the colour display.

## 1.5 Flow diagram Aswan




The problem with this diagram is

- Flow measurement in the discharge. Now we must calculate the density in the discharge and convert in to the density in the suction to be able to calculate the flow in the suction.
- The anti surge valve open or closed does not make a lot difference to the flow through the process.




This looks like a better set up.

## 1.6 Design data / operating conditions

**Product specification:**

| | | |
|---|---|---|
| Fan type | HD2- 407/1230/T16B | |
| Motor power | 700 | [kW] |
| Motor speed | 3000 | [rpm] |

**Surge conditions:**

| | | |
|---|---|---|
| Mass flow (qm) | 17800 | [kg/h] |
| Density suction (Ro_in) | 4.145 | [kg/m3] |
| Volume flow (qv_in) | 4294 | [Am3/h] |
| Press diff (dp) | 1.834 | [bar] |
| Surge Limit Value 1 @ surge pint (SLV1) | 416.8 | [m4] |
| Surge Limit Value 2 (SLV2), Bypass open limit | +15 | [%] |
| Surge Limit Value 3 (SLV3), Controller setpoint | +15 | [%] |

**Cabinet Purge air:**

| | | |
|---|---|---|
| Pressure | 2.5 | [barg] |
| Capacity | 6500 | [Litre/hour] |

**Dimensions Cabinet:**

| | | |
|---|---|---|
| Type of control panel | Free standing Cabinet | |
| Height | 2002 | [mm] |
| Width | 800 | [mm] |
| Depth | 510 | [mm] |

**Passive Instruments:**

| Passive output signal | 4 [mA] | 20 [mA] | Units |
|---|---|---|---|
| | | | |
| Flow meter | 1500 | 8400 | [Am3/hr] |
| Temperature P100 | 0 | 200 | [Celsius] |
| Pressure inlet | 0 | 991200 | [Pa] |
| Pressure outlet | 0 | 991200 | [Pa] |
| By pass valve (spring valve oven, air close) | 100 | 0 | [% open] |
| | | | |

**TCP Modbus glass connection**

| | | |
|---|---|---|
| Primary IP address | 192.168.10.91 | [-] |
| Secondary IP address | 192.168.10.91 | [-] |

**PID Controller settings**

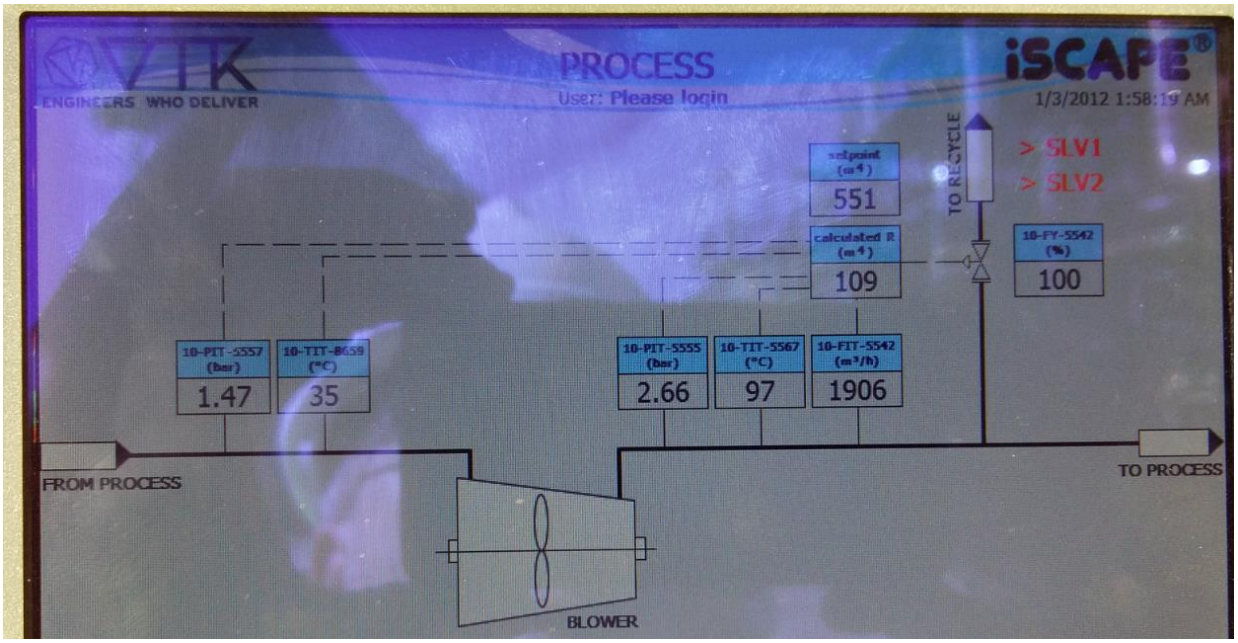
| | | |
|---|---|---|
| Proportional setting Kp | | [-] |
| Integral setting Ti | | [s] |

Please note the final setting shall be determined during the commissioning stage

**EXPLOSION PROTECTION CABINET**

Hazardous area classification : Ex II 3(1)G Ex pz [ia GA] IIC T4 Gc

### 1.7 Actual flow trough the recycle loop only.




Medium 100% N2 (mol weight 32 gr/mol)

**Discharge conditions**
P out = 2.66 barg
Tout = 97 Celsius
Density out= 2.038 kg/m3
Flow discharge 1906 Am3/hr

**Suction conditions**
P in = 1.47 barg
T in = 35 Celsius
Density in= 1.151 kg/m3
Flow suction flow must be 2.038/1.151*1906 = 3318 Am3/hr

It seems that the by-pass loop too small is.

## 2 Safety

### 2.1 In general

For safe operation and correct use, please follow up below instructions:

- Read this manual carefully before installation, employment or maintenance of the control panel.
- Make sure that this manual is always available to all users or operators of the control panel.
- Strictly follow up all instructions in this manual.
- Works to the control panel are to be carried out by authorized, trained, qualified and competent persons only.

**CAUTION:**

- Always interrupt the power supply to the control panel before carrying out any maintenance works. Use a voltage tester to check that the circuit is dead.
- Take measures to ensure that the power supply to the control panel remains interrupted and cannot be switched on by accident.
- Stay clear of the **bypass valve positioner** when the ASC is active, it can move violently and unexpected.

**WARNING:**

- Do not handle or lift a control panel or parts thereof alone. Request assistance when lifting heavy objects.
- Carry out the works in a neat, tidy, suitable place of work. Put tools away after use.
- Ensure that no unauthorized persons can enter the place of work.
- Ensure that no unauthorized persons can access the switchboard.
- Use lockable power supply switches. This enables all personnel carrying out works to put their lock on the power supply switch. This makes it visible to all who is working on the installation. Use of lockable power supply switches makes it impossible to switch on the power supply before release.

The control panels and this manual are manufactured and drawn up with the upmost care for safety and quality. VTK is not liable for any damages resulting from inaccurate or incorrect use of products supplied by VTK. Neither does VTK accept responsibility for damages resulting from inaccurate or incorrect follow-up of instructions in this manual.

## 2.2 Safety guards and stickers

The control panel is fitted with the following guards to prevent the risk of injury. The guards are provided with warning stickers “Do not remove while in operation”:

- Do not work inside the Control Cabinet with the

**WARNING:**

- Safety guards are only to be removed by qualified and competent personnel when the power supply to the control panel is interrupted and the power supply switch is locked.

**NOTE:**

- The above stickers have been applied to inform and warn against risk of injury. Check monthly that stickers are still readable, clean if necessary.

## 2.3 Residual risks

A risk assessment has been conducted to map possible hazards, severity of harm and their probability of occurrence when utilizing control panels. It follows from the risk assessment that the following residual risks cannot be eliminated by design, safe guarding or complementary protective measures:

| Residual risk’s | Possible injury | Action |
|---|---|---|
| 1: Unexpected By-pass valve movement | Risk of light injuries | Warn and instruct in the user manual: Stay clear of the bypass valve positioner when the ASC is active |
| 2: Explosion protection Control Cabinet | Risk of serious injuries | Warn and instruct in the user manual: |

# 3 System components

## 3.1 Controller cabinet

Stainless steel pressurized control cabinet suitable for ATEX zone 2.

## 3.2 Temperature transmitter

## 3.3 Pressure transmitter

## 3.4 Flow transmitter

This flow transmitter works in combination with an orifice plate


This flow transmitter works in combination with an orifice plate.

### 3.5 Bypass valve

Bypass valve size 6, spring to open”

## Calculation sheet blow-off valve

TAG No. 10-FV-5542

## Valve Performance

| Valve | | | Blow-off/ Recycle |
|---|---|---|---|
| | | Unit | |
| Upstream | Volume | [Am³/h] | 4218 |
| | Density | [kg/Am³] | 4.22 |
| | Temp. | [°C] | 88 |
| Upstream | Pressure | [mbarg) | 4492 |
| Downstream | Pressure | [mbarg] | 2936 |
| Δp inlet valve | | (mbarg] | 1556 |
| Mass flow | | [kg/h] | 17800 |

CALCULATION SHEET

| | | | |
|---|---|---|---|
| FLUID | : air | | (gas) |
| Critical Pressure: | bar a | 37.7 | |
| Critical Temp. | : °C | -140.7 | |

| SERVICE CONDITIONS | | MINIMUM | NORMAL | MAXIMUM | OTHER |
|---|---|---|---|---|---|
| Flowrate | : kg/h | | 17800 | | |
| Inlet Pressure | : bar g | | 4.492 | | |
| Outlet Pressure | : bar g | | 2.936 | | |
| Pressure Drop | : bar | | 1.556 | | |
| Temperature | : °C | | 88 | | |
| G | : | | 1 | | |
| Cp/Cv | : | | 1.4 | | |
| Z | : | | 1 | | |
| Fl | : | | 0.950 | | |
| Calculated Cv | : | | 267.6 | | |
| Outlet Mach | : (IEC) | | 0.204 | | |
| Sonic Diameter | : mm | | 67.79 | | |
| Outlet Pipe DN | : mm | | 300 | | |
| Schedule | : | | 40.0 | | |
| Valve SPL | : dBA (IEC) | | 69.6 | | |
| Lift% | : linear | | 92.3 | | |
| Signal% | : linear | | 92.3 | | |

| | | | | |
|---|---|---|---|---|
| PRODUCT TYPE | : LDM V322 Lo-dB | | | |
| Flow Direction | : - | Trim | : - | |
| Nominal Cv | : 290 | | | |
| Rating | : 150 | | | |
| Input Size | : 150 mm | Output | : 150 | mm |

ISA S75.01/IEC 534-2

$$K_v = Q\sqrt{\frac{SG}{\Delta P}}$$

where[3]

$K_v$ is the flow factor (expressed in $[m^3 . h^{-1} . bar^{-0.5}]$).

$Q$ is the flowrate (expressed in cubic metres per hour $[m^3/h]$),

SG is the specific gravity of the fluid (for water = 1),

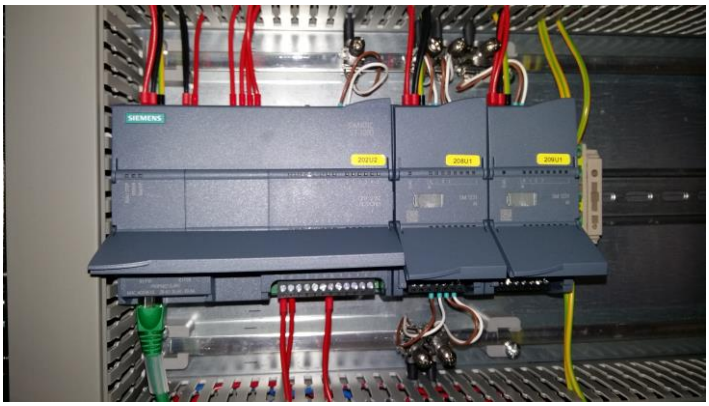
$\Delta P$ is the differential pressure across the device (expressed in [bar]).

$K_v$ can be calculated from $C_v$ using the equation[4] :

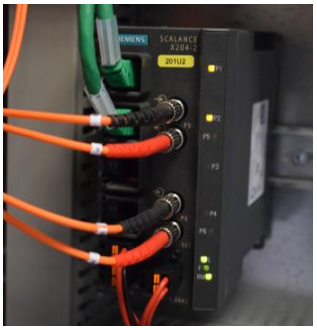
$$K_v = 0.865 \cdot C_v$$

# 4 Control cabinet Components

## 4.1 PLC, Siemens S7-1200




## 4.2 TCP Mod bus controller




## 4.3 Bartec Controller

Positioned on the right hand outside of the cabinet.

# 5 Installation, commission and start up

## 5.1 Transportation and storage

It is important that during transportation the control panel cannot slide or tip over. Please follow up below instructions:

**WARNING:**

- The control panel shall be packed with sufficient packing wood and to prevent it from sliding or tipping over.
- Secure the load by means of straps and slings or other aids which are fit for purpose.
- Preferably the load is carried within the limits of the works truck loading area, no parts of the load extending beyond.

## 5.2 Lifting instructions

**DANGER:**

It is important that during lifting operation the following instruction are followed up:

- The control cabinet is fitted with lifting lugs. When these are too small to fit the slings, the lugs need to be fitted with a shackle.
- At all times lifting operations need to be carried out using certified and approved lifting gear.
- The weight of the control cabinet is 160 kg
- Ensure proper securing of the area where the lifting work will take place.
- Ensure adequate supervision (competent staff) during lifting.
- Do not leave the load hanging unattended.
- Do never stand under the load.

## 5.3 Mechanical installation of the control cabinet

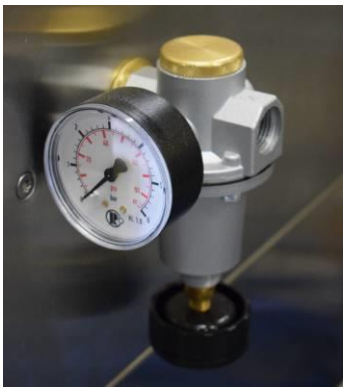
It is important that during installation of the control panel the following instructions are followed up:

**WARNING:**

- Installation of the control panel must be performed by authorised and suitably trained personnel.
- Position the control panel using the appropriate lifting means.
- Place the control panel in a stable position and secure the to the floor.

## 5.4 Pressurized air connection

Connect dry pressurized air to the pressure regulator mounted on the righthand side on the control panel. Set the pressure to 3 barg. This air will pressurize the inside of the control cabinet to meet the ATEX regulations.



## 5.5 TCP Modbus glass connection

The Control Cabinet glass connection shall be connected to the electrical system by a qualified technician.

## 5.6 Electrical mains connection

**DANGER:**

- The Control Cabinet shall be connected to the electrical system by a qualified electrician.

## 5.7 Special attention By-pass Valve prior to power-up

**WARNING:**

- Check if all instruments are in place.
- Check pneumatic connection Bypass Valve
- Check free movement of the Bypass valve.
- Check tightening of Bypass Valve gaskets.
- Check all instrument connections for leaks.

## 5.8 Panel internal 24V DC power supply

## 5.9 ATEX

**EXPLOSION PROTECTION**

Periodically check the following parts for wear and tear:

The Control Cabinet is equipped with a Bartek Pressurized cabinet system

| | |
|---|---|
| Type | A7-3703-1051/C3799834-10 |
| Ex protection type | Ex II 3(1)G Ex pz [ia GA] IIC T4 Gc |
| Certificate | BVS 11 ATEX E145 |
| Rated Voltage | 2x 230 VAC 1P+N+E |
| Min purge gas flow | 6500 litre/hr |
| Min purge pressure | 2.5 bar |
| Min overpressure | 0.8 mbar |
| Max overpressure | 10 mbar |
| Ambient | -20 Celsius to + 50 Celsius |

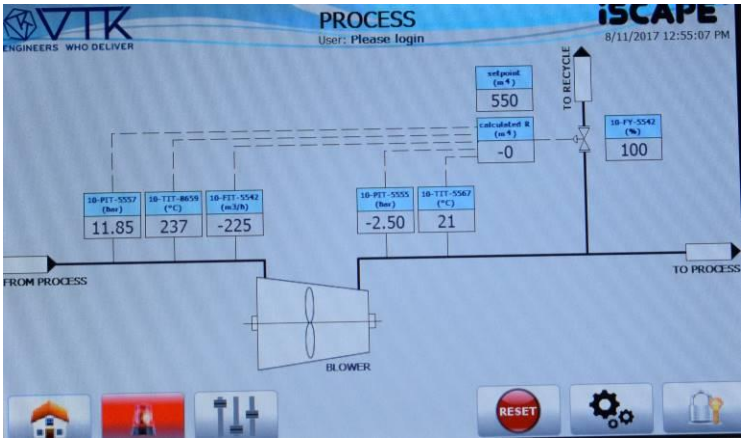

Bartec controller, air feed pressure and the purge air connection

### 5.9.1 The Bartec unit

This controls and protects and controls the air pressure inside the cabinet and air flow to the cabinet. When this system fails an alarm will be given and an alarm will be send to the DCS.

# 6 Anti-Surge Controller Screens

## 6.1 Process screen



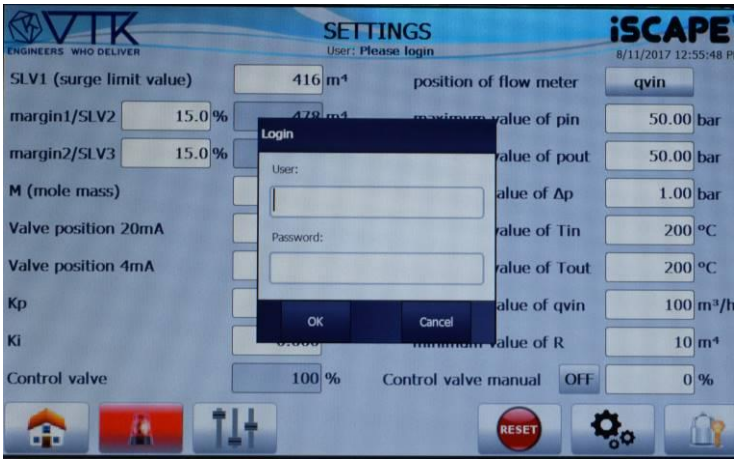

Note
The Bypass valve 100% indicates the Wide-Open Position (max flow).

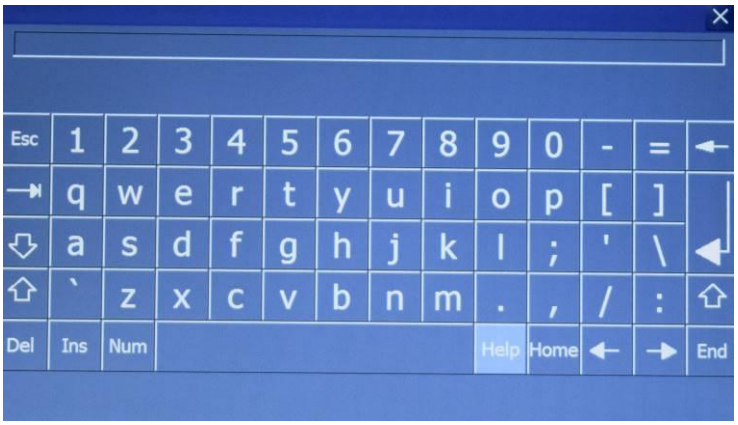
## 6.2 Alarm Screen


The alarms can be quitted with the reset button on the screen and the button on the panel door.
The panel is equipped with automatic reset, when the cause disappears so does the alarm indication.

There a two tabs, one for the actual alarms and one with an history overview.

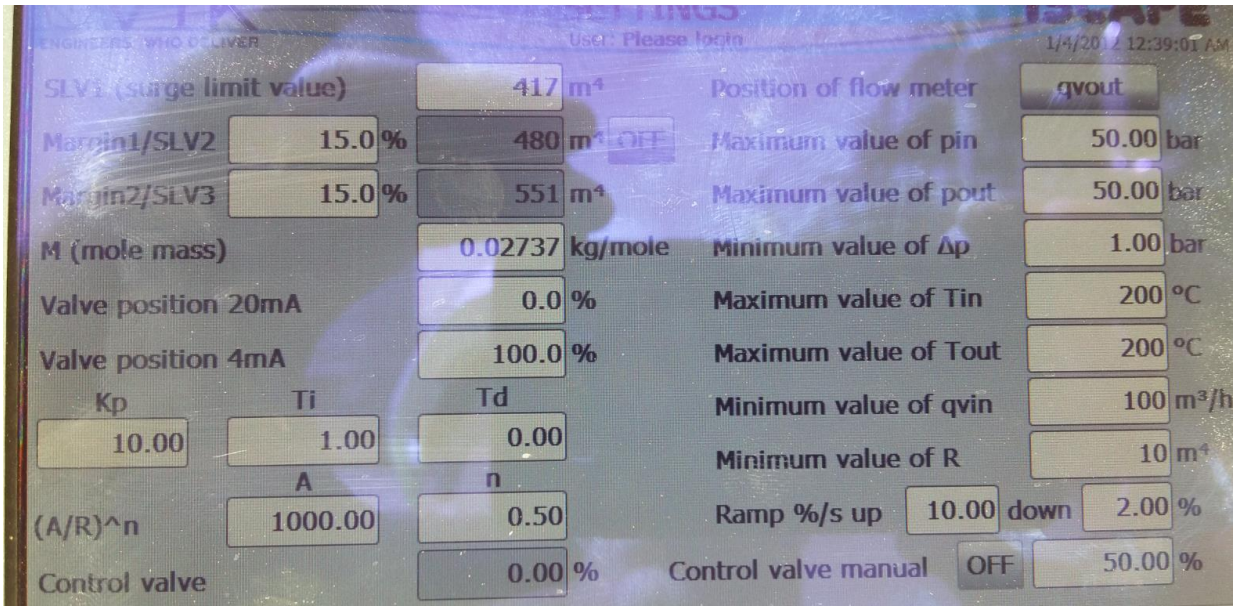
## 6.3 Log In screen




Log in allowed for authorised personal only see the used administration chapter.

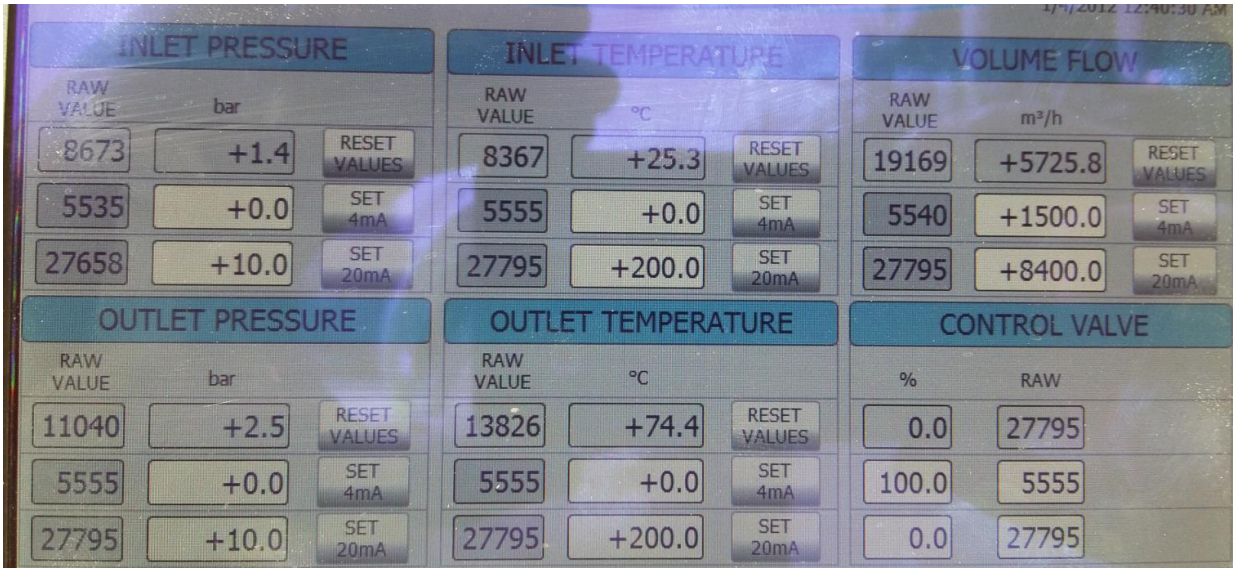
## 6.4 Settings screen




The settings screen is used to set

- SLV1 value (surge limit value)
- SLV2 value with ON/OFF button (Override start opening bypass valve)
- SLV3 value (setpoint for the PID controller)
- Mole mass gas in fan
- The Trip values (Bypass valve goes completely open @ trip)
  - Power supply 24V
  - Temperature inlet too high
  - Temperature outlet too high
  - QVin too low
  - Pressure fan inlet too high
  - Pressure fan outlet too high
  - Minimum delta-p over the fan
  - 
- The Alarm values
  - Minimum R value
- PID controller
  - Kip (proportional)
  - Ti (integral)
  - Td (differential)
- Control valve manual ON/OFF button
- Control valve ramp open (for limiting the load on the electric motor)
- Control valve ramp shut (for limiting the load on the electric motor)
- Position flow meter before/after de fan

## 6.5 Calibration screen




The calibration page is used to adopt the selected instruments range to the raw values in the control panel.

For example, the temperature transmitters generate 4 mA @ 0 Celsius and 20 mA @ 200 Celsius.
Use the instrument documentation to get the correct numbers.
Please note that the dark grey and white fields can be changed, by tapping on the field.

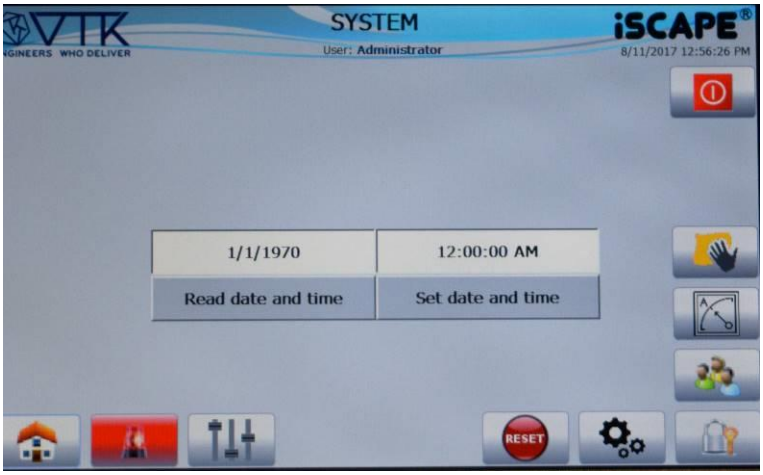
Bypass valve is also controlled with a 4-20 mA signal. 4 mA is shut and 20

Remark: This anti surge controller is setup for passive 4-20 mA signals and is not suitable for 0-10V signals.

Passive instruments are instruments without a separate power supply connection. The power supply is located inside the control cabinet and is brought to the instrument via the signal cabling.

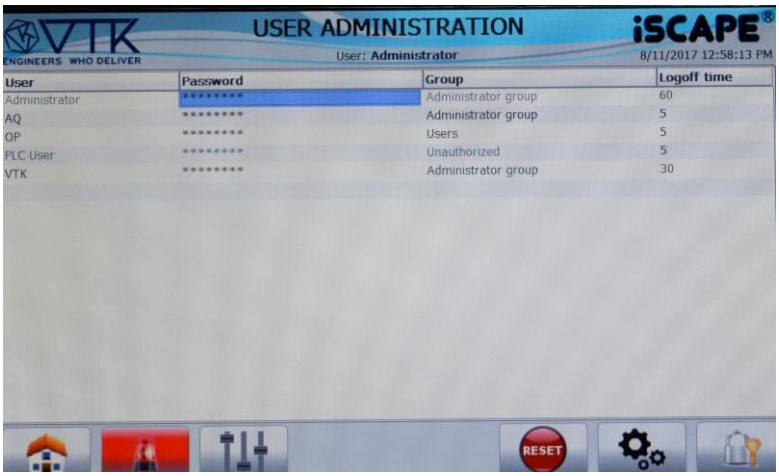
See chapter 1.5 for the instrument range information.

## 6.6 Date and Time screen




Setting time and date

## 6.7 User administration screen

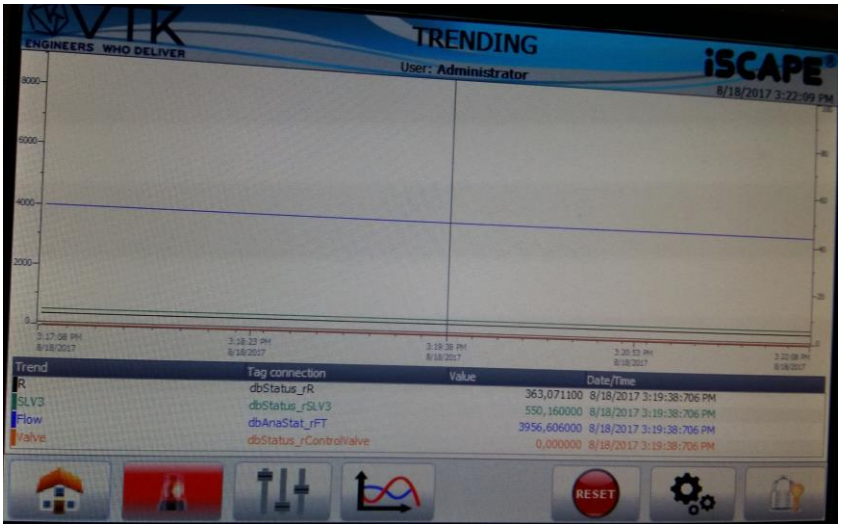



User administration.

**As administrator**.

User: as Password: 100
User: vtk Password: 1948rc (no spaces, small characters)

## 6.8 Process Trending screen




Move the vertical line in the middle of the screen to read the values presented at the bottom of the trending screen.

# 7 ASC panel Commissioning

## 7.1 Principle op operation

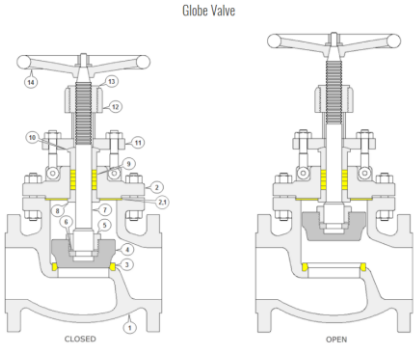
The PID controller controls on basis of SVL3, if the flow passing the fan is too low, the bypass valve is opened.

If the flow is still decreasing (despite the effort of the PID controller) and reaches SLV2 the supervisory control takes over and start to open the bypass valve rapidly.

## 7.2 Alarm

Make sure all alarm are resolved before running the actual complete system.

## 7.3 Instruments and bypass valves

- Check all instrument ranges
- Check all 4-20 mA range setting
- Check 8” bypass valve, Spring return 100%, air to close.
    - 4 mA is 100% open (Full flow)
    - 20 mA is 0% open (NO flow)
    - 

- Make sure that the temperature transmitters are not swapped
- Make sure that the pressure transmitters are not swapped
- Check all actual valves (temperature, pressure) are they realistic
- Check bypass valve on manual (open and closed)
- SLV2 and SVL3 both @ 15%

## 7.4 Initial PID controller setup

- Initial Settings
    - Kp= 0.1
    - Ti= 0.0 (integral action NOT active) Note Ti is very large also results in Not active
    - Td= 0.0 (differential action NOT active)

## 7.5 Initial Fan start up

- Check fan bearing oil level
- Grease motor bearings

- Check pressure sealing gas
- Start fan against closed main valve
- Check the fan rotation direction
- When at speed, ramp open main valve over a period of 30 seconds
- Check fan vibration
- Check motor current and speed
- Check for leaks
- Check bearing temperatures
- Check seal temperatures
- Run for 30 minutes keep checking the above
- Check gauge readout against instrument readout
- PID controller setup
- Switch PID to automatic (nothing should happen)
- Increase Kp controller until system becomes unstable, see figure 1
    - Make a note of the actual P_u value (P_ultimate)
    - Read T_ultimate
    - Reduce Kp half the present value (system calms down)
- Calculate proportional Gain, Kp= 0.45*Ku (Ziegler-Nichols method, see figure 2)
- Calculate integral time, Ti= Tu/1.2
- Document all mentioned variables or make and make a picture of the screens to make sure nothing is forgotten.
- Enter the calculated numbers into the ASC controller

Note is the system is not stable, the Kp value is too high, if the system is too slow the Kp is too low.

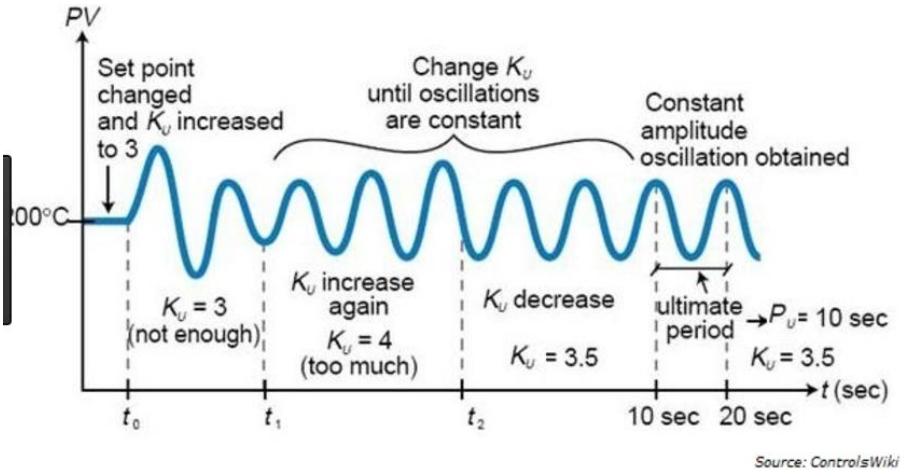



**Figure 1**

| Ziegler–Nichols method[1] | | | |
|---|---|---|---|
| **Control Type** | $K_p$ | $T_i$ | $T_d$ |
| *P* | $0.5K_u$ | - | - |
| *PI* | $0.45K_u$ | $T_u/1.2$ | - |
| *PD* | $0.8K_u$ | - | $T_u/8$ |
| *classic PID*[2] | $0.60K_u$ | $T_u/2$ | $T_u/8$ |
| *Pessen Integral Rule*[2] | $0.7K_u$ | $T_u/2.5$ | $3T_u/20$ |
| *some overshoot*[2] | $0.33K_u$ | $T_u/2$ | $T_u/3$ |
| *no overshoot*[2] | $0.2K_u$ | $T_u/2$ | $T_u/3$ |

**Figure 2**

# Troubleshooting

## 7.6 Alarm troubleshooting

The following alarms are incorporated.

| Alarm | Possible cause | Action |
|---|---|---|
| Error glass switch | Glass Modbus connection to DCS | Check and repair |
| Inlet temperature wire break | Bad connection or broken wire | Check and repair |
| Inlet pressure wire break | Bad connection or broken wire | Check and repair |
| Inlet temperature too high | Process problem | Check your process |
| Outlet temperature wire break | Bad connection or broken wire | Check and repair |
| Outlet pressure wire break | Bad connection or broken wire | Check and repair |
| Outlet temperature too high | Flow too low | Increase the flow |
| Volume flow wire break | Bad connection or broken wire | Check and repair |
| Qvin too low | Bad transmitter of fan not running | Check |
| R to low | Bad transmitter of fan not running | Check |
| Pressure difference too low | Bad transmitter of fan not running | Check |
| ATEX | Pressurized air pressure low | Check air supply pressure |
| ATEX | Pressurized air pressure low | Close panel door |
| | | |

## 7.7 Components troubleshooting

| Component | Symptoms | Possible cause | Action |
|---|---|---|---|
| Display | Does not light up | No power | Check main switch |
| Display | Alarm is given | Read the alarm message | Fix the given fault. |
| Bypass valve | Does not respond | Pressurized air pressure low | Check air supply pressure |
| Bypass valve | Does not respond | Valve is stuck | Free the valve |
| Bypass valve | Does not respond | Flow, pressure, temperature transmitter does not function properly. | Check transmitter readout on the display than check that transmitter. |
| | | | |
| Bypass valve | Too slow | PID setting | Increase Kp |
| Bypass valve | Hunting, instable | PID setting | Decrease Kp |
| | | | |
| | | | |

# 8 Maintenance and inspection

## 8.1 General operating and maintenance instructions

**WARNING:**

- Do not start the work without a work permit
- Always interrupt the power supply to the control panel before carrying out any maintenance works.
- Use lockable power supply switches, this enables all personnel carrying out works to put their lock on the power supply switch. This makes it visible to all who is working on the installation. Use of lockable power supply switches makes it impossible to switch on the power supply before release.
- Make sure all personal protective equipment is available before attempting any works and make correct use of them.
- Personnel carrying out installation, repair or maintenance works shall obey the safety rules and regulations.
- Carefully maintain control panels as per the maintenance instructions in this manual.
- Do not pollute the environment.
- Maintenance/repair to the control panel are to be carried out by qualified and competent persons only.

## 8.2 Questions

If you have questions or recommendations, or want to order spare parts, please quote the following information:

- VTK reference number (name plate).
- Exact email address.
- Name and contact details of the contact person.
- If possible, a description of the malfunction. A sound description of the symptoms with pictures will aid us in quickly resolving the malfunction.

Our contact details:

Van Tongeren kennemer bv

Postcode NL - 1948 RC Beverwijk
E-mail: info@vtk.nl
Phone.(+31)251-229160