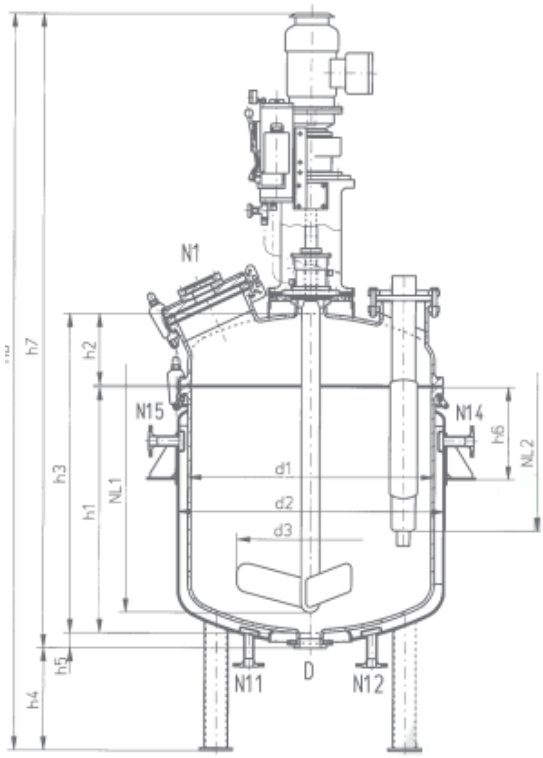
Shanghai EDA Medical & Pharmaceutical Technology Co., Ltd.

Telephone / Fax：+86 21 37026221
Email： info@edapm.com

搪玻璃反应釜高精度控温单元
GL-TCU: Glass Lined System with Temperature Control Unit



Pic.1 国标搪玻璃反应釜
glass lined reactor_GB

Pic.2 欧标搪玻璃反应釜
glass lined reactor_DIN

搪玻璃反应釜物料温度很难控制在± 1℃以内，主要是以下几个因素：

1）夹套式传热，热传导不均匀（存在死角），响应慢；

2）釜内搪玻璃层热阻大（瓷层导热系数小）；

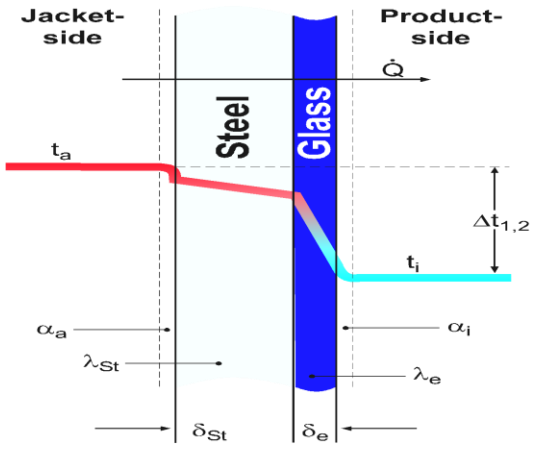
It is difficult to control medium temperature within glass lined vessels within range ± 1℃, for the reasons that:

1) Uneven heat transfer and slow response due to jacketed design;
2) High thermal resistance of glass lining within vessel

总传热系数 K (overall heat transfer coefficient)

$$\dot{Q} = k \cdot A \cdot \Delta t_m$$

$$k = \frac{1}{1/\alpha i + 1/\alpha a + (\delta/\lambda)st + (\delta/\lambda)e}$$



Pic.3 搪玻璃的热传导
heat transfer in between glass lined steel

ta --- 服务流体侧 (夹套)温度

• Service fluid side (jacket) temperature

ti --- 过程流体侧(罐内)温度

•Process fluid side (inner vessel) temperature

αa --- 服务流体侧传热膜系数

•Service fluid side heat-transfer film coefficient

αi --- 过程流体侧传热膜系数

•Process fluid side heat-transfer film coefficient

λst --- 钢的导热系数

•Heat-transfer coefficient of steel

λ e --- 搪玻璃层的导热系数

•Heat-transfer coefficient of glass lining

3）每个反应釜搪玻璃层的厚度不同（非机械化生产）；
4）无法采用大的温度差传导（搪玻璃在温差大的时候会爆瓷），无法用常规的仪表控制；
5）仪表的自整定功能在搪玻璃反应釜物料控制中失效。

3) Thickness difference between each glass lined reactor, due to non-mechanized production;
4) Can not use huge temperature difference for heat transfer, for concern of glass failure due to thermal shock to glass lining; can not use conventional instruments for control.
5) Failure of self-adjustment function of instruments in the control of mediums inside glass lined reactors.

Pic.4 冷热温差急变引起的搪玻璃失效
Glass failure due to thermal shock/cold shock

如何实现搪玻璃反应釜温度高精度控制?

- 首先从硬件改变。
- 提高导热（冷）媒介的流量。
- 提高所有温度传感器的精度。
- 提高TCU出口（夹套的入口）的媒介控温精度。
- 不再采用以往的串级调节的方式，用PLC程序加PID方式进行精准控制。

How to achieve high-precision temperature control of a glass lined reactor?

- Firstly, changing from hardware;
- Increase flow rate of heating/cooling mediums;
- Increase precision of all temperature sensors;
- Increase temperature control precision of TCU (Temperature Control Unit) outlet (i.e. inlet of jacket);
- Using PLC (Programmable Logic Controller) with PID (proportion, integral, differential) to utilize precision control, to replace conventi

Pic.5 强化传热喷嘴
Heat-transfer reinforced jet nozzle

我们的TCU是如何来达到精准控温?

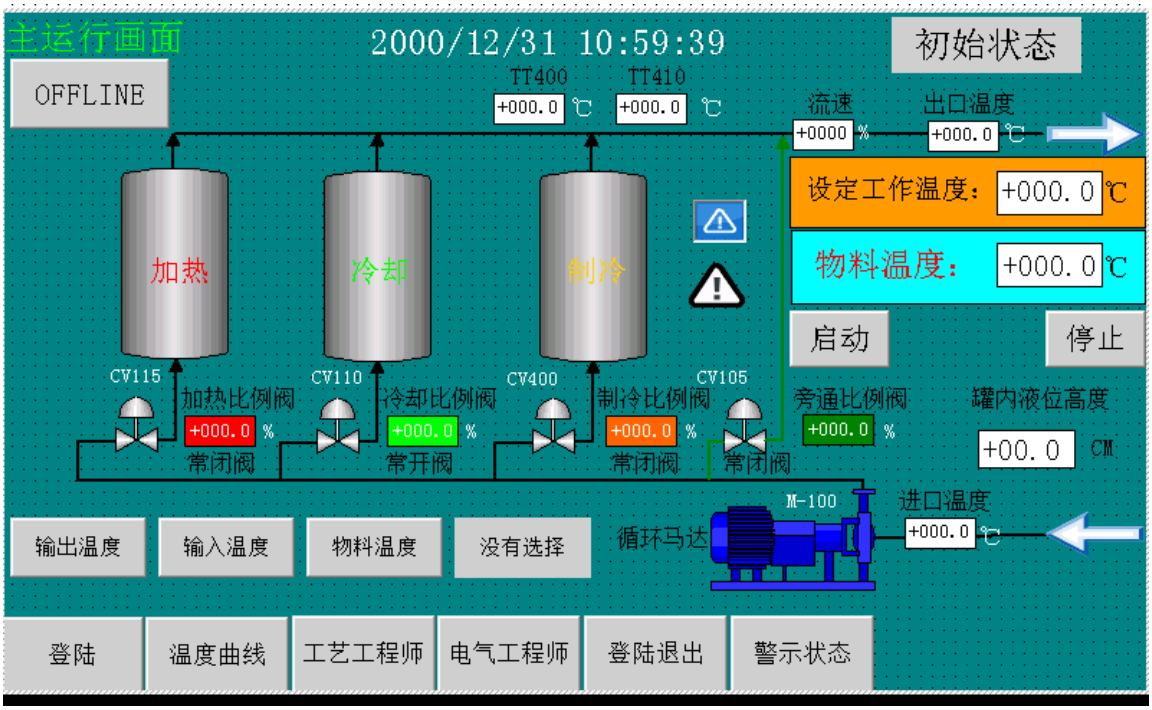
- 首先是引入旁通阀的理念，将进入反应釜夹套媒介温度的控制精度在± 0.2℃以内
- 增加循环泵的流量，增加换热效率。
- 采用强化传热喷嘴（消灭死角）。
- 经过多年对TCU的调试经验，采用不同于常规的控制方式。
- 针对特定的反应，我们可以做到物料温度控制在± 0.5℃以内。
- 通用的程序也能做到物料温度控制在± 1℃以内。

How our TCU achieve high precision temperature control?

- Firstly, we introduce the idea of a bypass-valve, which can control temperature of jacket medium within ± 0.2℃ precision.
- Increasing flow rate of circulating pump, to increase heat transfer efficiency.
- Using heat-transfer reinforced jet nozzle.
- Using unconventional control from our years of TCU debugging experience.
- For specific reaction, we can control material temperature with ± 0.5℃ precision.
- Our general program can also achieve precise temperature control within ± 1℃.

控制屏主界面图

Home Page of Control Panel (other language optional)



Pic.6 控制系统主界面
Home page of control system

我们的TCU可以有多种控制方式选择：

- 反应釜物料温度
- 夹套入口温度
- 夹套温度
- 梯级升温速率及保温时间可控
- 快速降温功能
- 自动跟踪物料及夹套温度差，保证搪玻璃不损坏

Many Control Options of our TCU for selection：

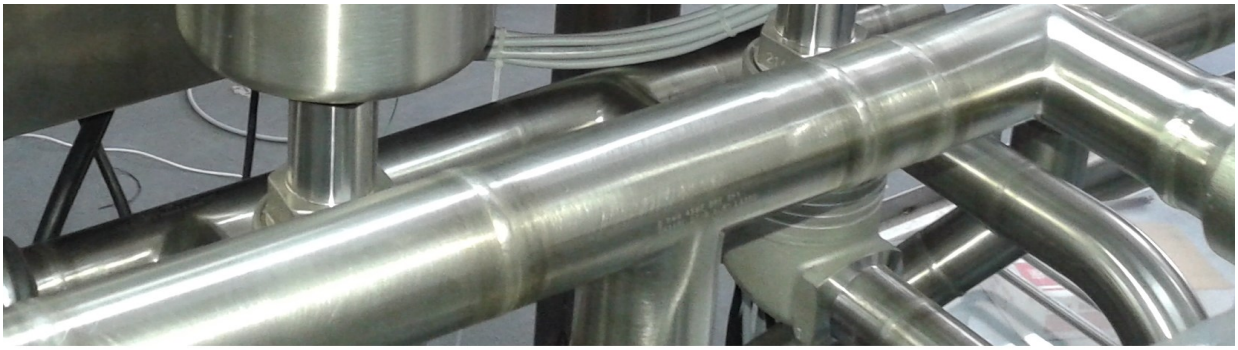
- Material temperature in reactor
- Temperature of jacket inlet
- Temperature in jacket
- Cascade heating rate and holding time controllable
- Fast cooling performance
- Monitoring temperature difference between materials and jacket automatically, to prevent glass lining failure due to sudden temperature change

设备材料主要介绍

➢ 所有夹套循环管道采用S304

Main Materials

- All jacket circulation pipelines are S304 stainless steel



Pic.7 夹套循环管道
jacket circulation pipelines

➢ 循环泵采用宽温高质量磁力泵（格兰富）

- Circulating pump is Grundfos made, which is high quality and with wide temperature range

Pic.8 格兰富磁力泵
Grundfos magnetic pump

设备材料主要介绍

- 调节阀采用宽温等比例阀（宝德）

Main Materials

- Regulating valve is Burkert made, which is equal proportion with wide temperature range.

Pic.9 宝德等比例阀
Burkert proportion regulating valve

- 高精度温度传感器（E+H）

- High precision temperature sensor is E+H made.

Pic.10 E+H高精度温度传感器
E+H high precision temperature sensor

设备材料主要介绍

- 控制系统及屏采用西门子

Main Materials

- Control system as well as control panel is SIEMENS made.

Pic.11 西门子控制系统
SIEMENS control system

在调试及使用过程中碰到的问题及解决的方法

- 使用温度范围比较大管道经过数次升降温（特别是在高低温差比较大的情况下，因为冷热的变化范围比较大，密封部分的变形量比较大，连接处非常不易做密封。）就会漏，所以常规情况下，只能采用焊接或法兰连接。
- 过压保护安全阀，对反应釜，泵及管道都有保护作用，但在不正常操作及特别情况出现安全阀动作时，使TCU内媒介外流，即不安全又浪费，我们采用外泄口接管回收。
- 在连续加温时，管道内会出现爆鸣现象，在设备中使用缓冲罐来避免这一现象的发生，以杜绝其他隐患。

Problems and solutions during debugging & production stage

- **Problem 1 & solution:** Pipelines with huge temperature difference between heating and cooling are easy to leak after several rounds of running, due to big deformation of sealing parts. **Therefore, we chose welding or flange connection for connection between pipes and fittings.**
- **Problem 2 & solution**: Safety valves for over pressure protection are good for reactors, pumps and pipelines. Nevertheless, when mis-operation or emergency triggers the safety valves, mediums will flow out from TCU, which is not safe and a waste of money. **For such concern, we design reflux ports with recycling pipelines.**
- **Problem & solution**: During continuous heating, there will be explosion sound in pipelines. **We add buffer tank in our TCU to stop this from happening.**

参考图片 | **Reference Pictures**

Pic.12 控制箱
Control box

参考图片 | Reference Pictures

Pic.13 保温
Insulation

参考图片 | **Reference Pictures**

Pic.14 执行单元
Actuating unit