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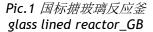
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搪玻璃反应釜高精度控温单元 GL-TCU: Glass Lined System with Temperature Control Unit



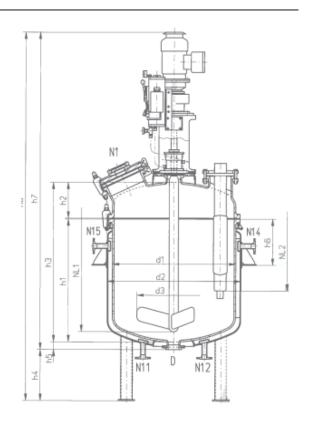






搪玻璃反应釜物料温度很难控制在± 1℃ 以内,主要是以下几个因素:

- 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)



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

It is difficult to control medium temperature within glass lined vessels within range \pm 1°C, for the reasons that:

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

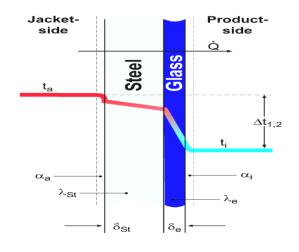
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总传热系数 K (overall heat transfer coefficient)

$$\overset{\bullet}{Q} = k \cdot A \cdot \Delta t_m$$

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



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
- aa --- 服务流体侧传热膜系数
 •Service fluid side heat-transfer
 film coefficient
- ai --- 过程流体侧传热膜系数•Process fluid side heat-transfer film coefficient
- Ast --- 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?

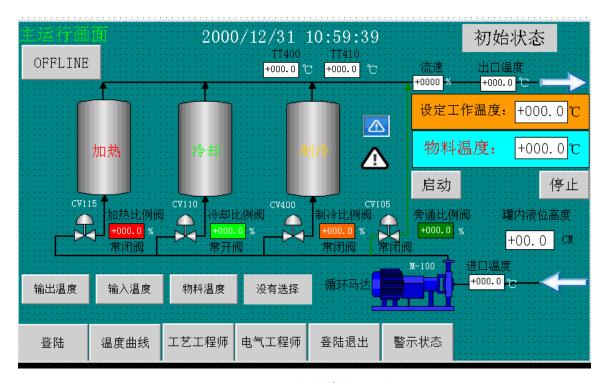
- ▶ 首先是引入旁通阀的理念,将进入反应釜 夹套媒介温度的控制精度在± 0.2℃以内
- ▶ 增加循环泵的流量,增加换热效率。
- > 采用强化传热喷嘴(消灭死角)。
- ➤ 经过多年对TCU的调试经验,采用不同于 常规的控制方式。
- ▶ 针对特定的反应,我们可以做到物料温度 控制在± 0.5℃以内。
- ▶ 通用的程序也能做到物料温度控制在± 1℃以内。

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 \pm 0.2°C 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 \pm 0.5°C precision.
- Our general program can also achieve precise temperature control within \pm 1°C.



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 \$304 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