

中国石油工程建设协会



PFR软件基本功能介绍



国家AAAA级协会

HSOFT

北京华思维信息技术有限公司
BEIJING HSW INFORMATION TECHNOLOGY CO.,LTD.

主讲人简介



王德瑞

王德瑞，中石化广州（洛阳）工程有限公司工业炉专业教授级高工。1997年作为中石化代表团成员之一，赴美参加FRNC-5PC、REFORM-3PC的PFR培训。

二十多年来，应用FRNC-5PC、REFORM-3PC程序，设计、审核了几十台火焰加热炉、十几台制氢转化炉的工程设计。

三十多年来，在加热炉、制氢转化炉领域获得了20余项专利，其中多项专利产品在工程设计中应用，效果良好。

近十年来，参与了盛虹石化、浙江石化、云南石化、广西石化、四川石化千万吨级炼化一体化项目加热炉的设计。

参编了SH/T3036-2003/2012《一般炼油装置火焰加热炉》标准。

主编了SH/T3037-2003/2016《炼油厂加热炉炉管壁厚计算方法》标准。

中石化科技部2008年《铸铁式空气预热器的研发及工业应用》课题负责人，2010年研发产品开始工业应用。

中石化科技部2016年《蓄热式空气预热器的研发和工业应用》课题负责人，2019年研发产品开始工业应用。



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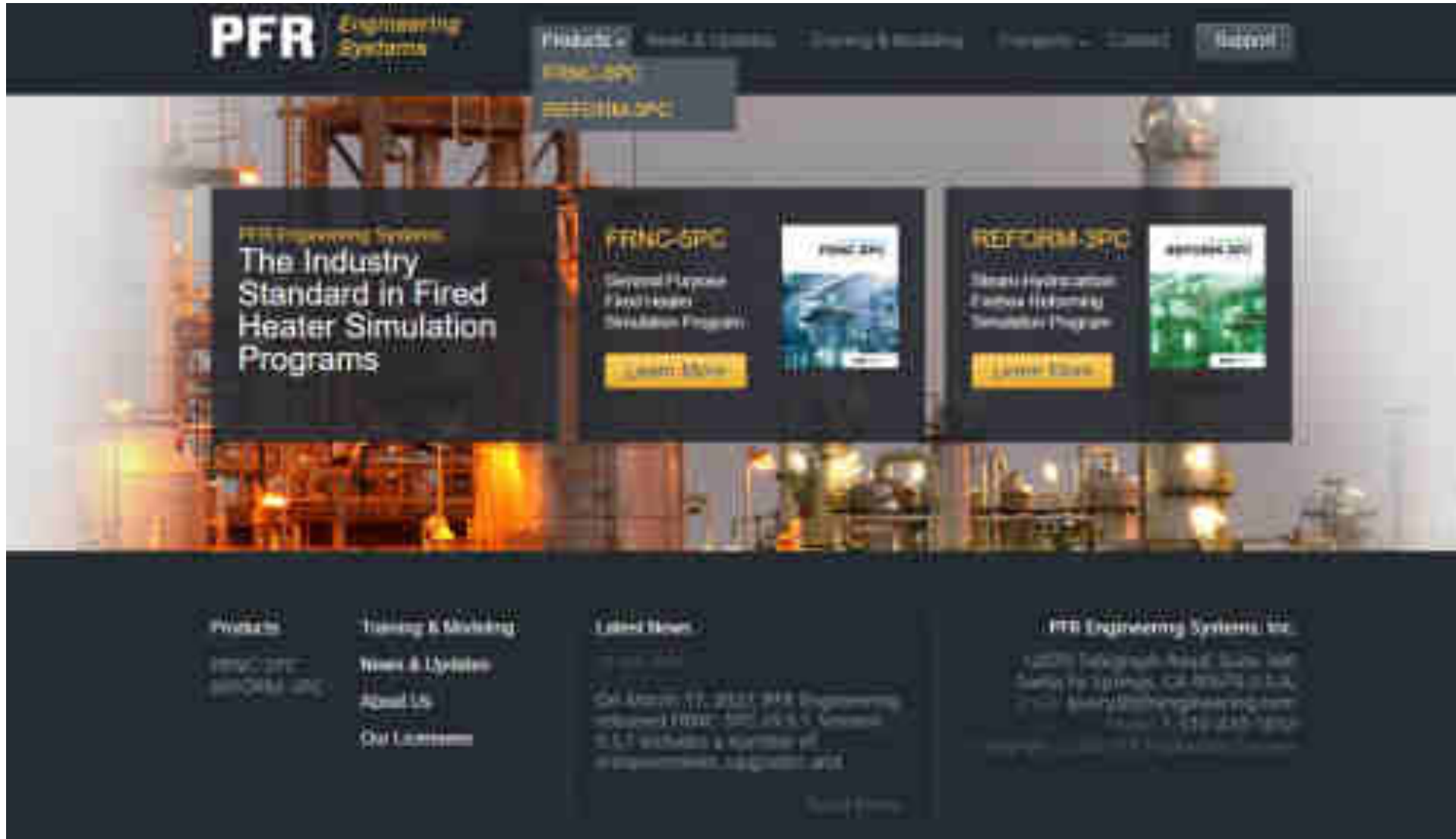
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PFR公司官网



PFR's History in Providing Thermal Services

PFR was founded in January 1972 to provide advanced thermal engineering services in the energy industry, specializing in software simulation of equipment used in the oil and petrochemical fields. Our software roots began with a program used to simulate air-cooled heat exchangers in the oil and utility industries. This program was well received, allowing PFR to expand its software offerings to include more complex simulations, namely fired heaters and furnaces.

In 1975, PFR began marketing the FRNC-5 mainframe program, initially developed by PFR for the Chevron Research and Development Company. The FRNC-5 program was originally developed to simulate fired heaters, furnaces, and boilers, and that continued to be its primary application to this day.

The FRNC brought an expansion to our product offerings. PFR developed and released two additional mainframe programs: FURCRACK (which models high temperature cracking furnaces like ethylene furnaces) and REFORM-3 (which models Steam Methane Reforming furnaces). These programs expanded the furnace modeling capabilities of the PFR software suite.

Following the advent of the desktop computer, PFR released PC versions of FRNC-5PC and REFORM-3PC, two most popular simulation software products. This release, coupled with the wide availability of Windows software, brought both FRNC-5PC and REFORM-3PC to a multitude of engineers, designers, and program users that had previously not had access to such powerful tools. This allowed for rapid adoption of these programs across all areas of the oil and petrochemical industries. Today, these software programs have become the industry standard for fired heater and furnace design, utilized by the top fired heater manufacturers, EPCs, and oil companies around the world.

In 2009, PFR was acquired by Process Development of Heurtey Petrochem. Subsequently, Heurtey Petrochem was acquired by Axens, a wholly owned subsidiary of IFPEN. Today, PFR is a wholly owned subsidiary, but we continue to run the business with the same independence as we always have. In addition, having the support of a global entity such as Axens has allowed PFR to focus on software development and customer engagement, improving our ability to create value for our customers and the industries they support.

PFR continues to be focused on providing industry-leading fired heater simulation software and unparalleled service, training, and support for our customers worldwide.

PFR的历史

PFR成立于1972年1月，旨在为能源行业提供先进的热能工程服务，专门从事石油和石化领域所用设备的软件模拟。我们的软件起源于一个用于模拟石油和公用事业行业中风冷式热交换器的程序。该程序广受好评，使PFR能够扩展其软件产品，以包括更复杂的模拟，即火焰加热炉。

1975年，PFR开始销售FRNC-5大型机程序，该程序最初由PFR为Chevron研发公司开发。FRNC-5程序最初是为了模拟火焰加热炉和锅炉而开发的，直到今天，这仍然是其主要应用。

20世纪80年代，我们的产品范围不断扩大。PFR开发并发布了另外两个大型机程序：FURCRACK（模拟乙烯炉等高温裂解炉）和REFORM-3（模拟烃类蒸汽转化炉）。这些程序扩展了PFR软件套件的加热炉建模功能。

随着台式计算机的出现，PFR发布了FRNC-5PC和REFORM--3PC的PC版本，这是他们最受欢迎的仿真软件产品。这个版本，加上Windows软件的广泛可用性，将FRNC-5PC和REFORM--3PC带给了许多以前无法访问如此强大工具的工程师，设计师和程序用户。这使得这些程序能够在石油和石化行业的所有领域迅速采用。如今，这些软件程序已成为火焰加热炉领域的行业标准，被全球顶级火焰加热炉制造商、EPC承包商和石油公司所采用。

2009年，PFR被Heurtey石油化工的石油化工发展部收购。随后，Heurtey石油化工被IFPEN的全资子公司Axens收购。今天，PFR是一家全资子公司，但我们继续以一如既往的独立性经营业务。此外，在Axens等全球实体的支持下，PFR能够专注于软件开发和客户参与，从而提高我们为客户及其支持的行业创造价值的的能力。

PFR继续专注于为全球客户提供行业领先的火焰加热炉模拟软件和无与伦比的服务，培训和支持。



FRNC-5PC

FRNC-5PC

General Purpose Heater Simulation Program

FRNC-5PC is a leading program for general purpose fired heaters. It simulates most heater types, coil configurations, tube and fin types, and external transfer lines. It can simulate the heat recovery sections of all types of furnaces, boilers and turbines. It also has a user friendly graphical input system.

通用加热炉模拟程序

FRNC-5PC 是通用火焰加热炉的模拟程序。它可以模拟大多数加热炉辐射段，包括盘管布置、炉管和扩面管类型以及转油线等。它可以模拟所有加热炉、锅炉的余热回收部分。具有用户友好的图形输入界面。

- ✔ Reduce Heater Operating Costs 降低加热炉运行成本
- ✔ Increase Heater Capacity 增加加热炉负荷
- ✔ Troubleshoot Heater Problems 排查加热炉问题
- ✔ Check New Heater Designs 检查新加热炉的设计
- ✔ Evaluate Process Changes 流程变更评估
- ✔ Minimize Unplanned Shutdowns 最大限度地减少计划外停炉
- ✔ Model Process Controls 模拟过程控制



FRNC-5PC 是通用火焰加热炉的模拟程序。它可以根据用户提供的加热炉几何形状、燃烧数据和物流信息，通过程序计算获得运行参数，例如燃料量、热效率、管壁温度和需要的炉管壁厚、烟气侧温度和抽力、物流温度、压降和流型、热负荷和热强度等等。

FRNC-5PC 可以模拟大多数火焰加热炉的辐射部分，包括炉膛、盘管、炉管和扩面管形式、烟道、烟囱和转油线。

FRNC-5PC 可以模拟所有类型的加热炉、锅炉的余热回收部分。

FRNC-5PC 具有用户友好的图形输入界面和用户可选择的多个输出选项，例如加热炉数据表、图形输出、电子表格输出和表格输出。输入系统包含在线帮助和输入限制和错误检查。

FRNC-5PC 的主要功能

•降低加热炉运行成本

- 降低加热炉能耗
- 评估余热回收效益

•增加加热炉负荷

- 评估热负荷增加后的压降和抽力裕量
- 评估热负荷增加后，物流方面的限制

•流程变更评估

- 流速、温度和组分的变化
- 注汽后的变化
- 流型和汽化率的改变
- HAZOP分析和过程安全管理审查

•检查新的加热炉设计

- 成本优化
- 辐射室热效率水平
- 整个加热炉效率的水平

•最大限度地减少计划外停机

- 提供详细的管壁温度，预防超温
- 评估结垢和结焦，定期清焦
- 辅助排查加热炉故障，消除隐患

软件主要特点

本软件采用模块化方法来描述加热炉的工艺过程。软件将加热炉分成炉段模块、管组模块、炉管模块、物流模块、燃烧模块、燃料模块等。

炉段（加热段）模块

炉段模块指炉膛的炉气的空间，包括辐射室、对流室、烟道等。在辐射室和对流室模块中，通过按一定次序对特定管组模块的引用，可描述各种复杂的排管形式。

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管组模块

管组模块表示一组具有相对特点的管束，它被炉段模块所引用，同时，它引用炉管模块与物流模块。

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炉管模块

炉管模块是具有特定材质、扩径形式和几何尺寸的单根炉管。而一个炉管模块可以被不同的管组模块所引用。

物流模块

物流模块被管组模块所引用。

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燃烧模块

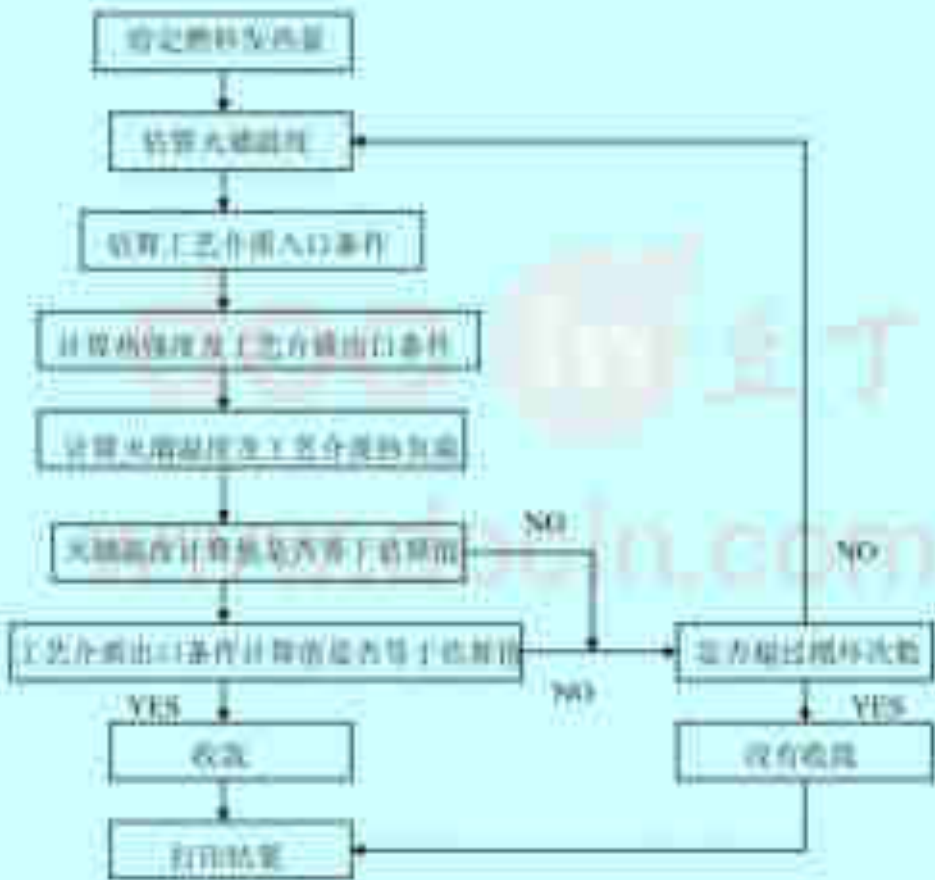
燃烧模块与辐射室相对应。燃烧模块定义了燃烧发热量、燃料种类等。

燃料模块

燃料模块被燃烧模块所引用。

FRNC-5PC计算方法

FRNC-5PC计算框图(固定发热量)



FRNC-5PC计算框图(固定热负荷)



软件评价

1. 具有很强的炉型适应性，便于比较与选择

软件适用于单一或多个辐射室、对流室、烟道和烟囱的各种布置形式，可以有一系列并联或串联的对流室；辐射室与对流室之间、对流室与对流室之间可以通过一系列并联或串联的烟道连接；对流室和烟囱可以顶置或底置。这种灵活性，在国内软件中还是不多见的。这主要因为通过对加热炉各部分的功能进行模块化分解，然后通过模块的组合实现加热炉各部分功能的组合。

以往国内软件大多直接从炉型出发对加热炉的功能进行分解，一旦炉型考虑不周或出现新炉型则难以适应。

软件对于各种复杂炉型计算的灵活性，为加热炉设计中的炉型选择、炉型综合甚至炉型创新提供了更大的想象空间。可以设计出更加经济合理和安全适用的炉型。这一点在大型加热炉的设计中尤其显得重要。

2. 具有很强的排管适应性，使管排设计更为合理先进

软件适用于单一或多种介质在加热炉内的各种流程。

加热炉设计的传统做法是：根据管内介质流速经验数据，确定管程数和炉管外径与壁厚；根据平均热强度经验数据确定管排面积；最后根据管内介质压降限制和炉管壁厚要求进行调整。其结果比较粗糙，不够经济。

该软件可计算出每根炉管的工艺参数，根据SH/T 3037（或API 530）计算的各管组所需最小管壁平均厚度等参数。设计可据此合理选择各段的管程数和排管面积以及每根炉管的材质、外径与壁厚，采用合理的排烟温度以避免低温腐蚀等。

软件评价（续）

3. 采用了较为先进的计算方法

对传统的辐射段Lobe-Evans方法进行了改进，将原方法中烟气对整个冷平面的辐射传热计算细化为对每个管单元的辐射传热计算；并假设了一个烟气辐射温度用于辐射传热计算，而桥墙温度用于辐射热平衡计算。此方法的桥墙温度更接近于现场标定值。

软件在内膜传热、管内压降、流型判别等方面所做的工作，无论从深度还是从广度上，都是国内大多数软件难以相比的。

4. 具有较完善的物性库

物性库中包括70种常用标准组份、用沸点和比重表示的拟组份、用蒸馏数据表示的未定义碳氢混合物以及物性网格等，能满足石油化工火焰加热炉的要求。还可提供多种接口辅助输入物性网格。

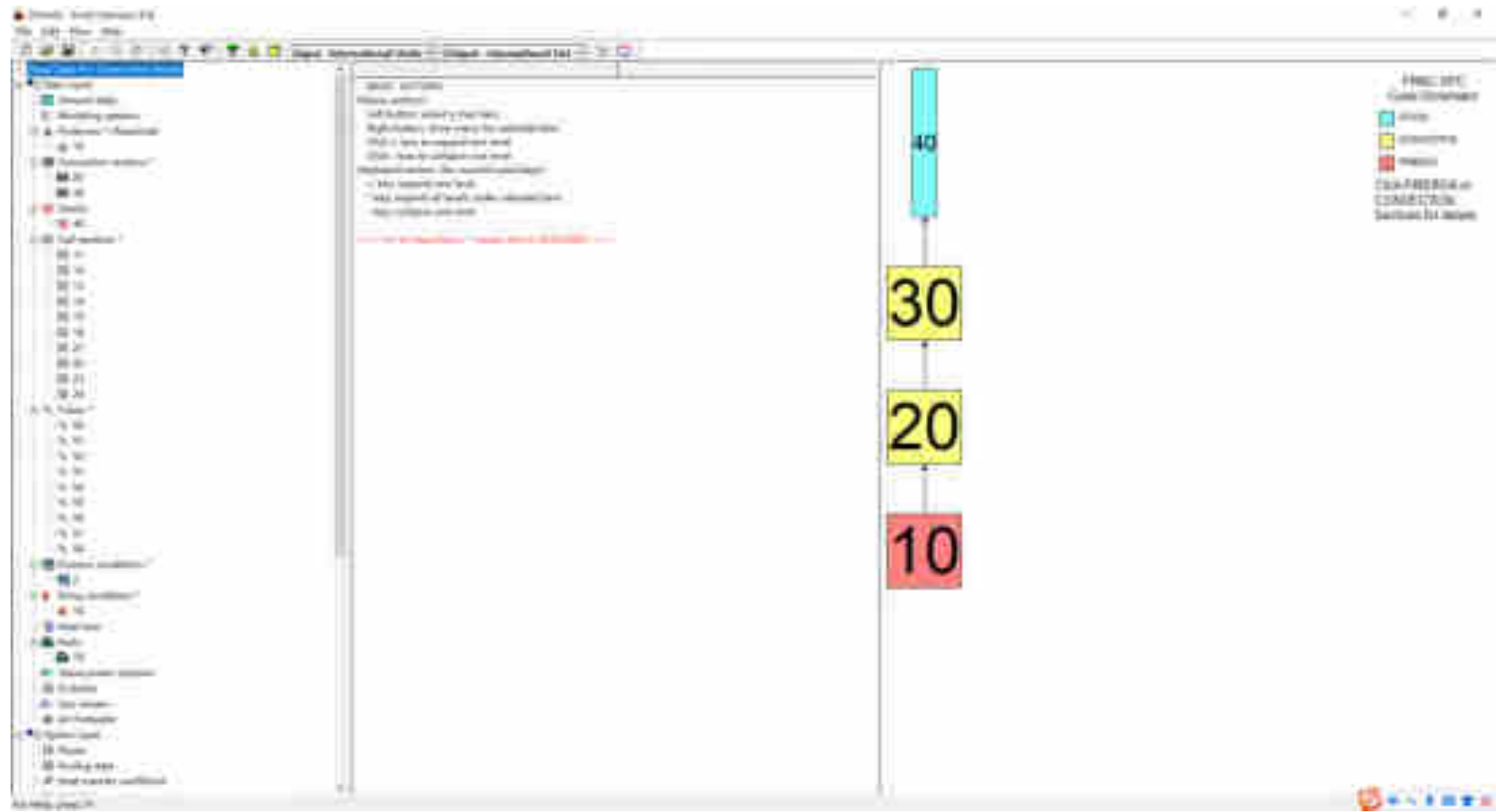
5. 具有十分全面的输出信息

软件除全面提供加热炉总体和局部的设计指标、炉中各部位烟气状态、管内各部位物流状态等信息外，还提供炉膛正压、管壁超温和扩面管超温、超临界流速以及露点腐蚀等方面的警告信息。

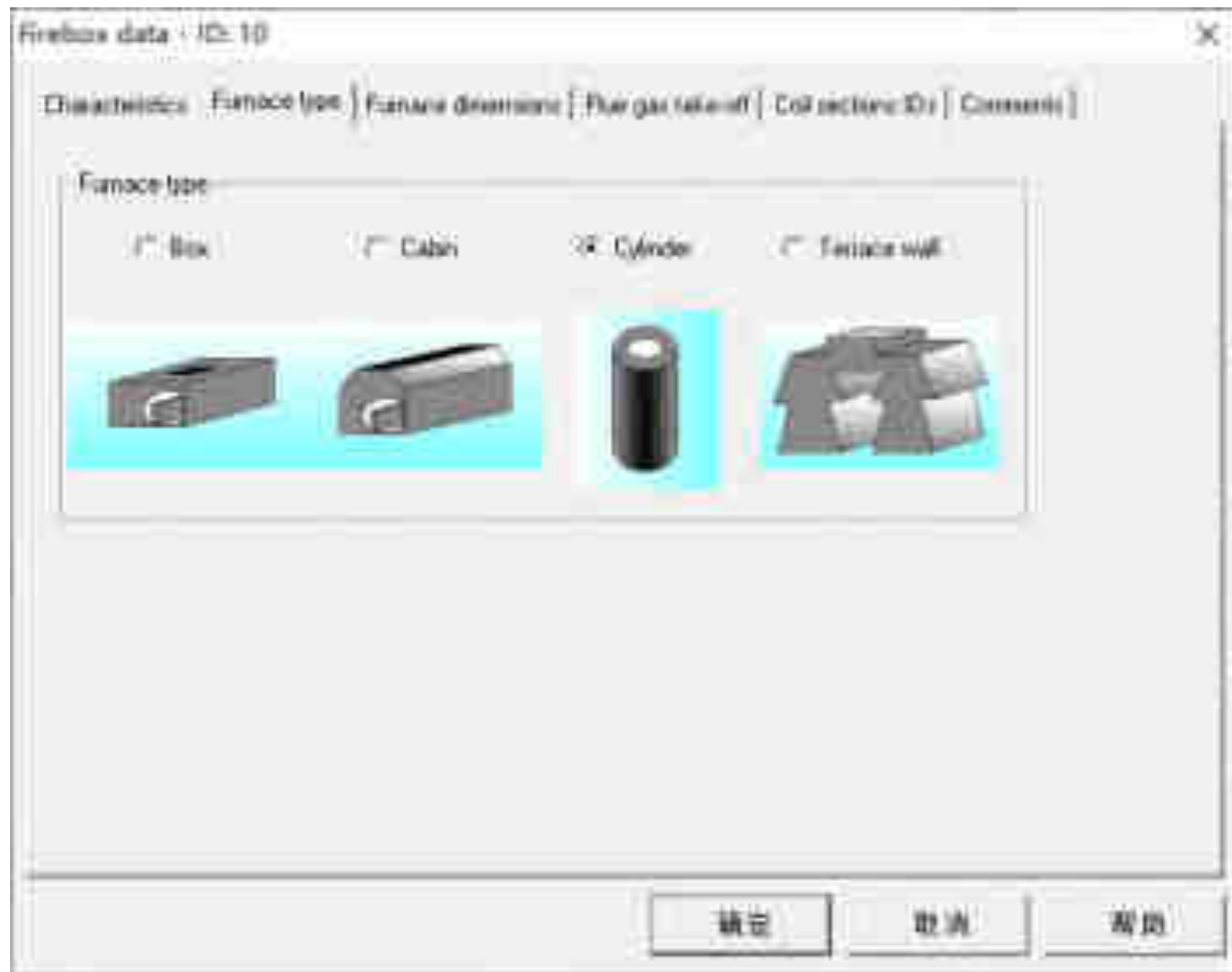
6. 具有十分友好的用户界面

软件通过图像屏幕界面，采用多级屏幕菜单的形式输入原始数据。所有数据项都有图形提示或在线帮助。输出文件中包括全面的错误分析信息，便于用户查找输入数据中的错误。

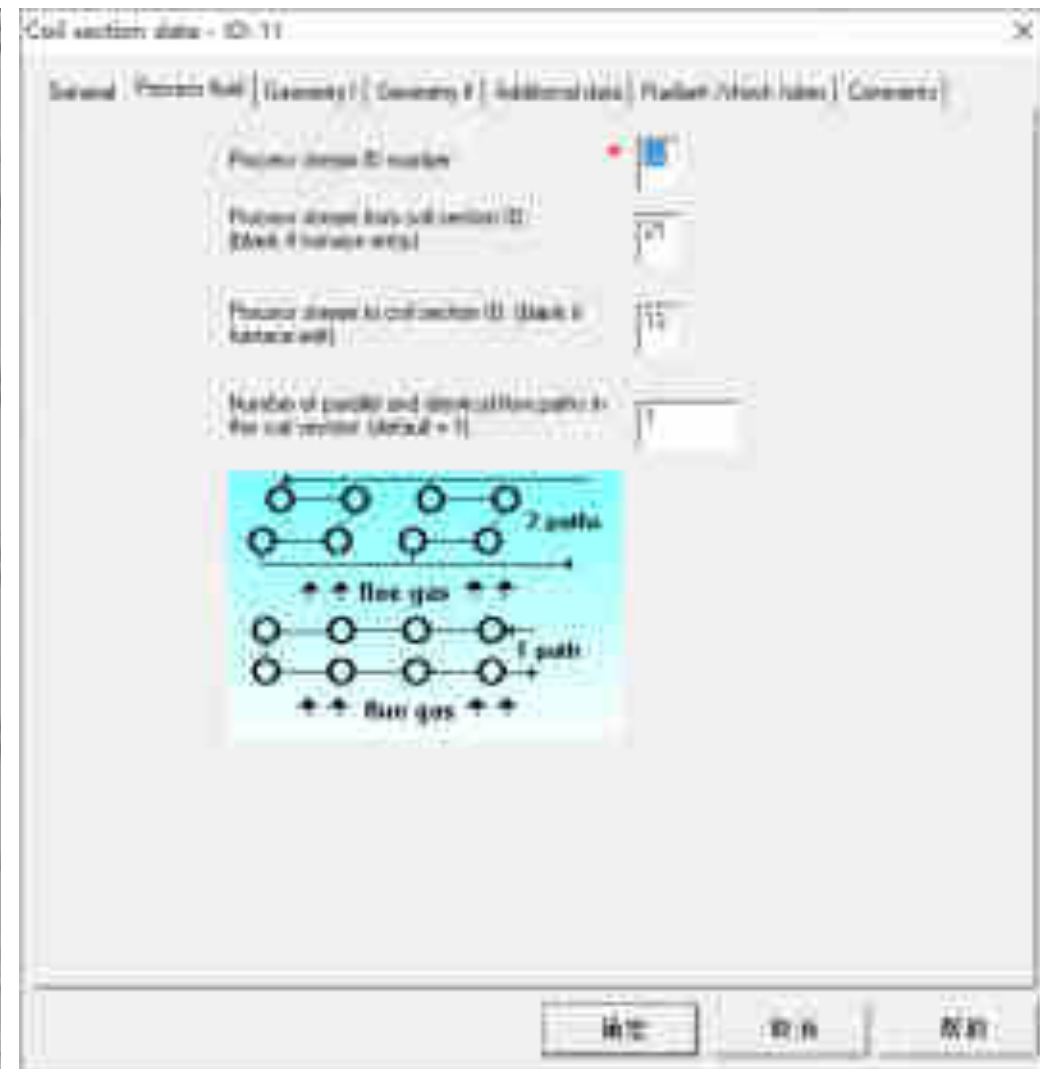
总输入界面



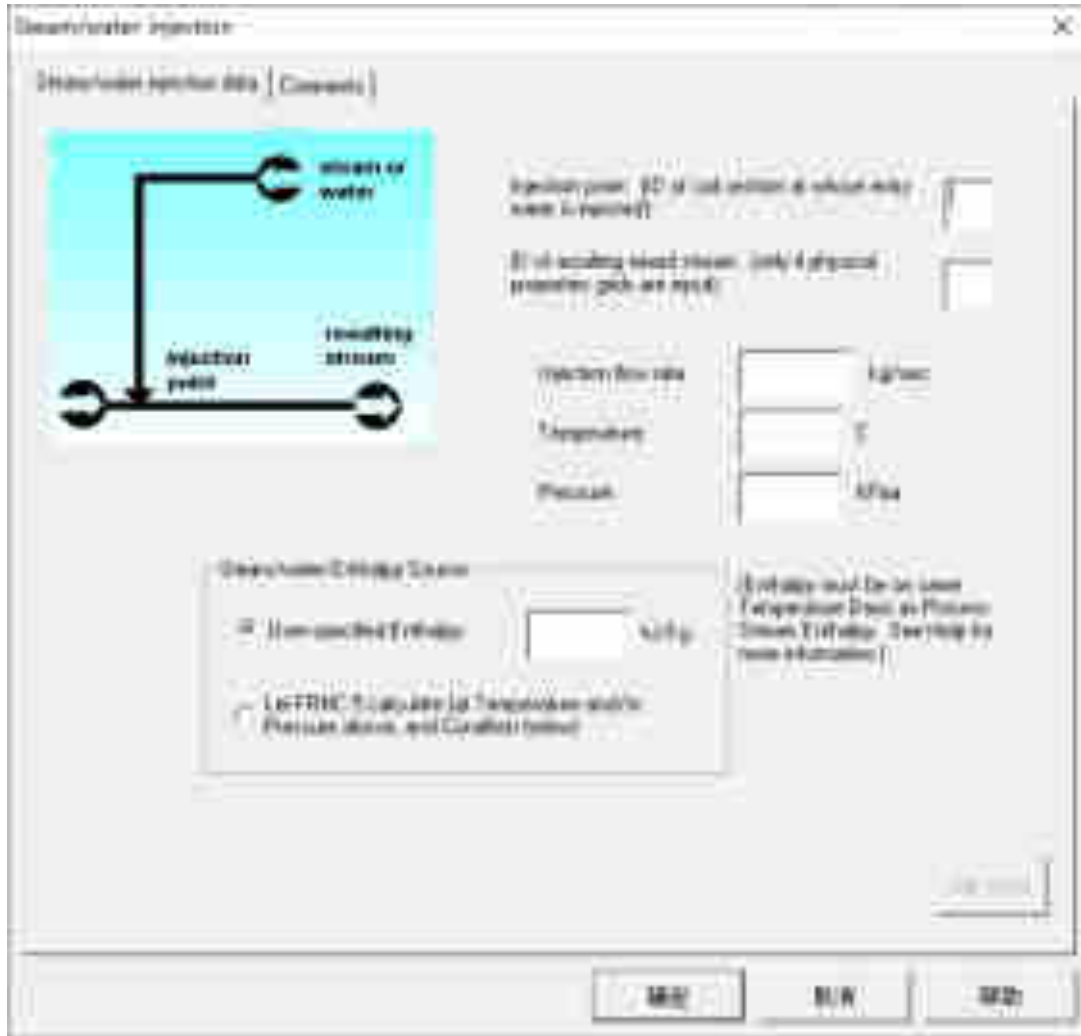
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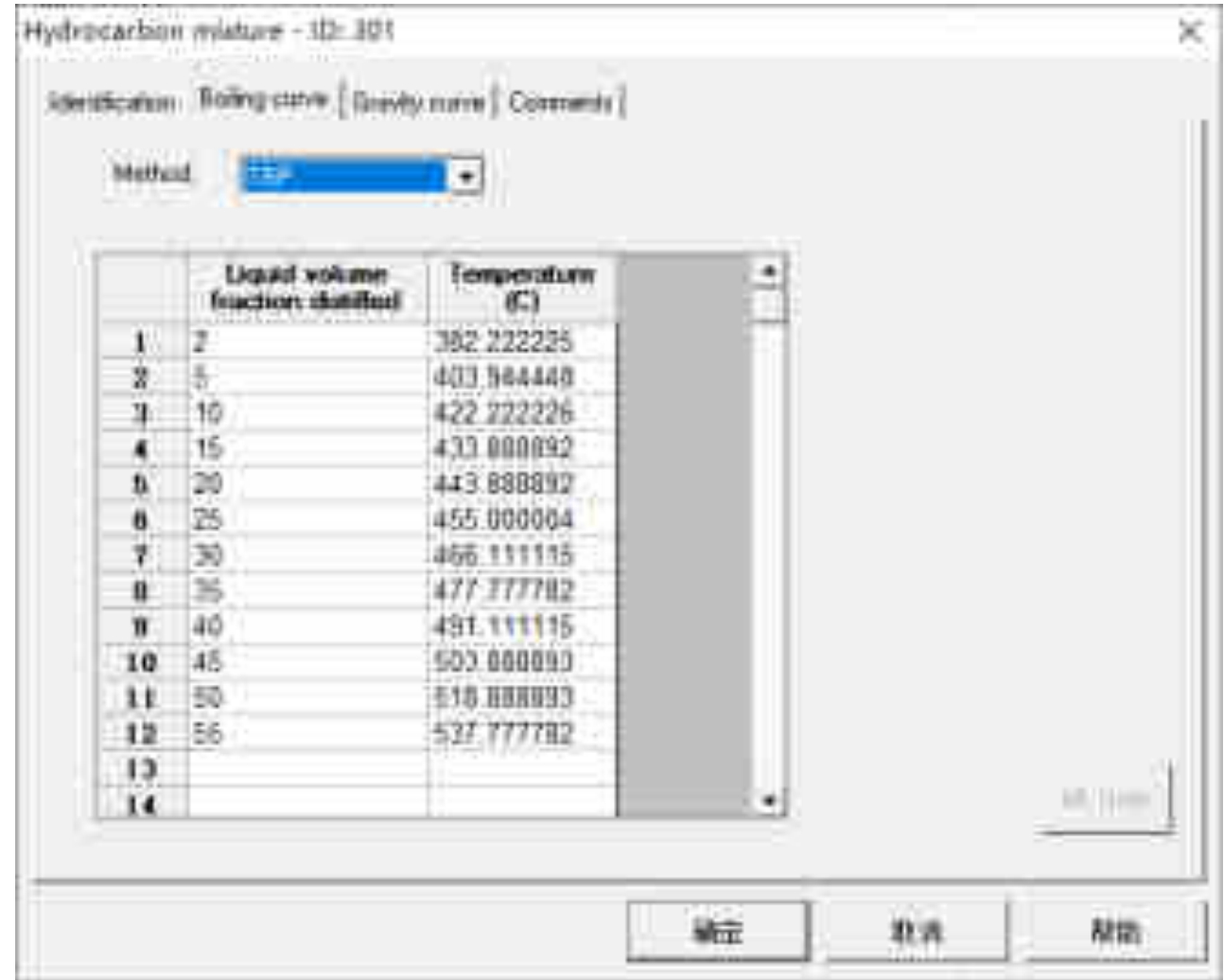
管组数据



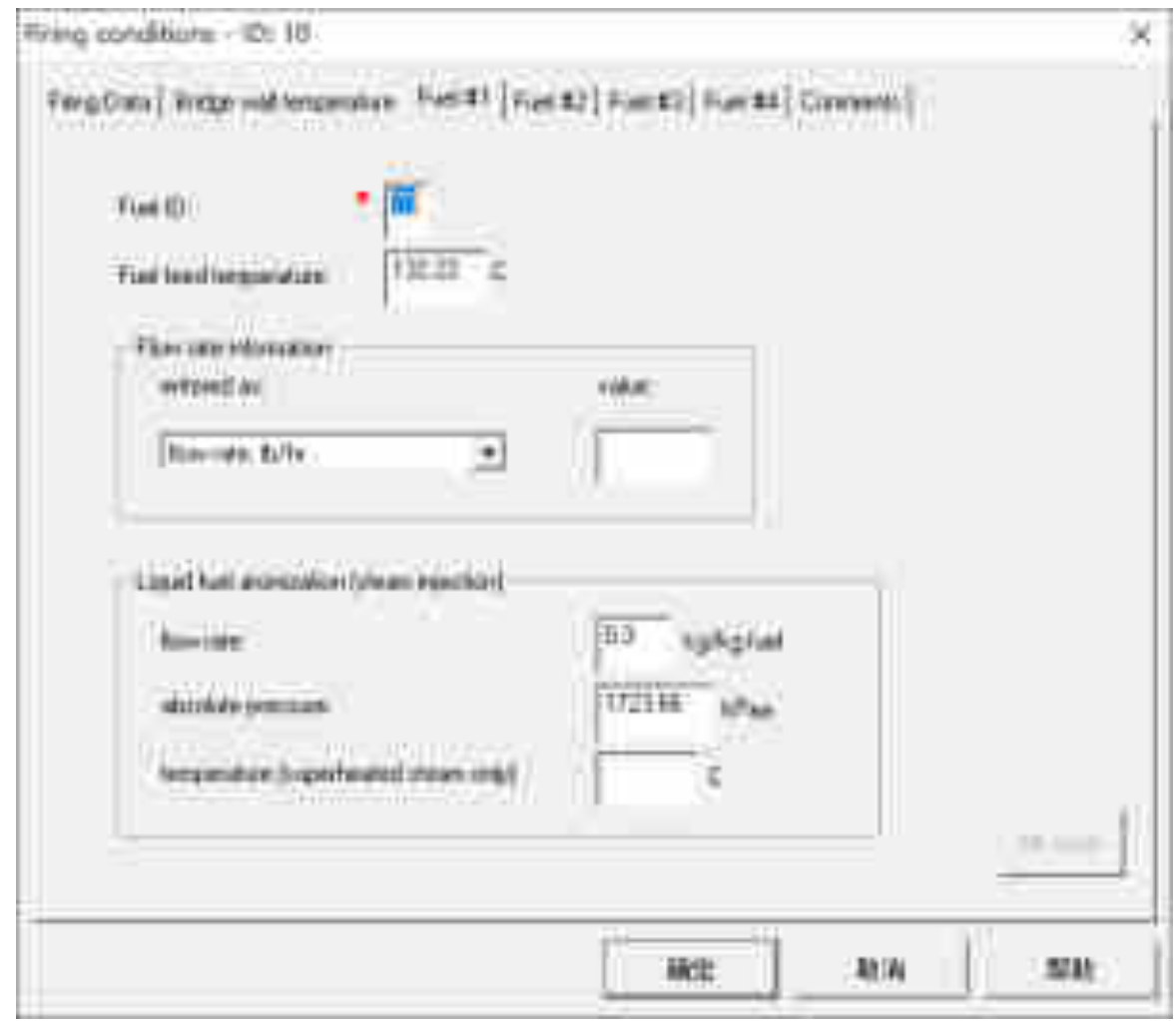
注汽/注水



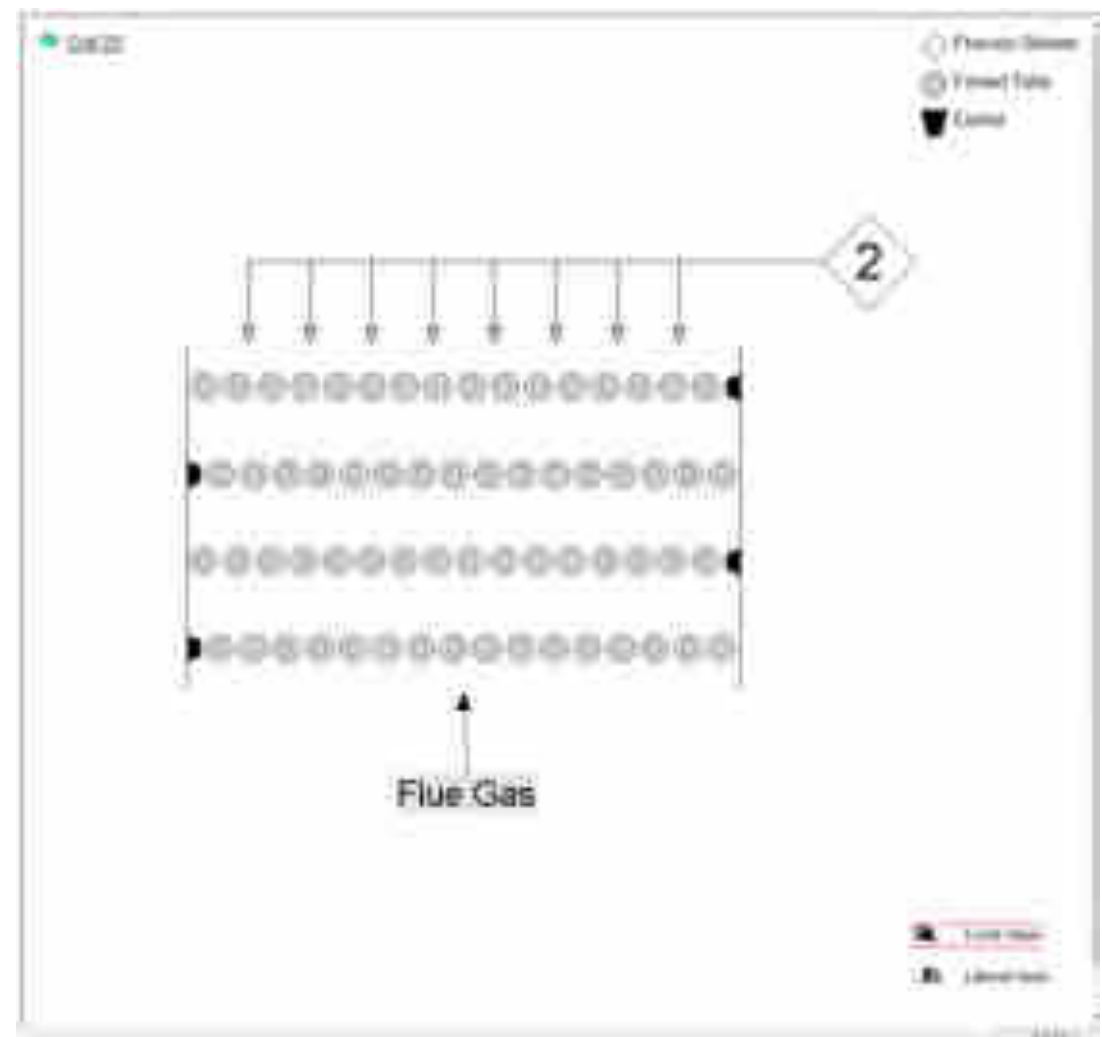
烃类混合物蒸馏数据



燃料



排管布置示意图



FRNC-5PC计算输出 首页

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-- SEE LISTED DATA SHEET (SHEET 040000) -- -- STAGE 02 - STG 02 -- STAGE 02 -- 02
 -- STAGE 02 -- -- LOCATION - CALIFORNIA -- S.I. UNIT
 -- STAGE 02 - STAGE 02 -- STAGE 02 - STG 02 -- STAGE 02 - STG

-- SEE STG 02 STG 02 (SHEET 040000) --
 -- STAGE 02 (SHEET 040000) --
 -- STG 02 WITH STAGE 02 (SHEET 040000) --
 -- STAGE 02 WITH STAGE 02 (SHEET 040000) --

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		TOTAL STG 02 STG	

STAGE 02 - STG	STAGE 02 - STG	STAGE 02 - STG	STAGE 02 - STG
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TABLED STAGE INFORMATION CLASS STG 02 INFO

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||| Main Summary | TABLED STAGE INFORMATION | CLASS STG 02 INFO |

New: HOW TO CHECK FULL (PRINT FILE FOR PRINTING) MESSAGES

Table Output Load Output

输出界面

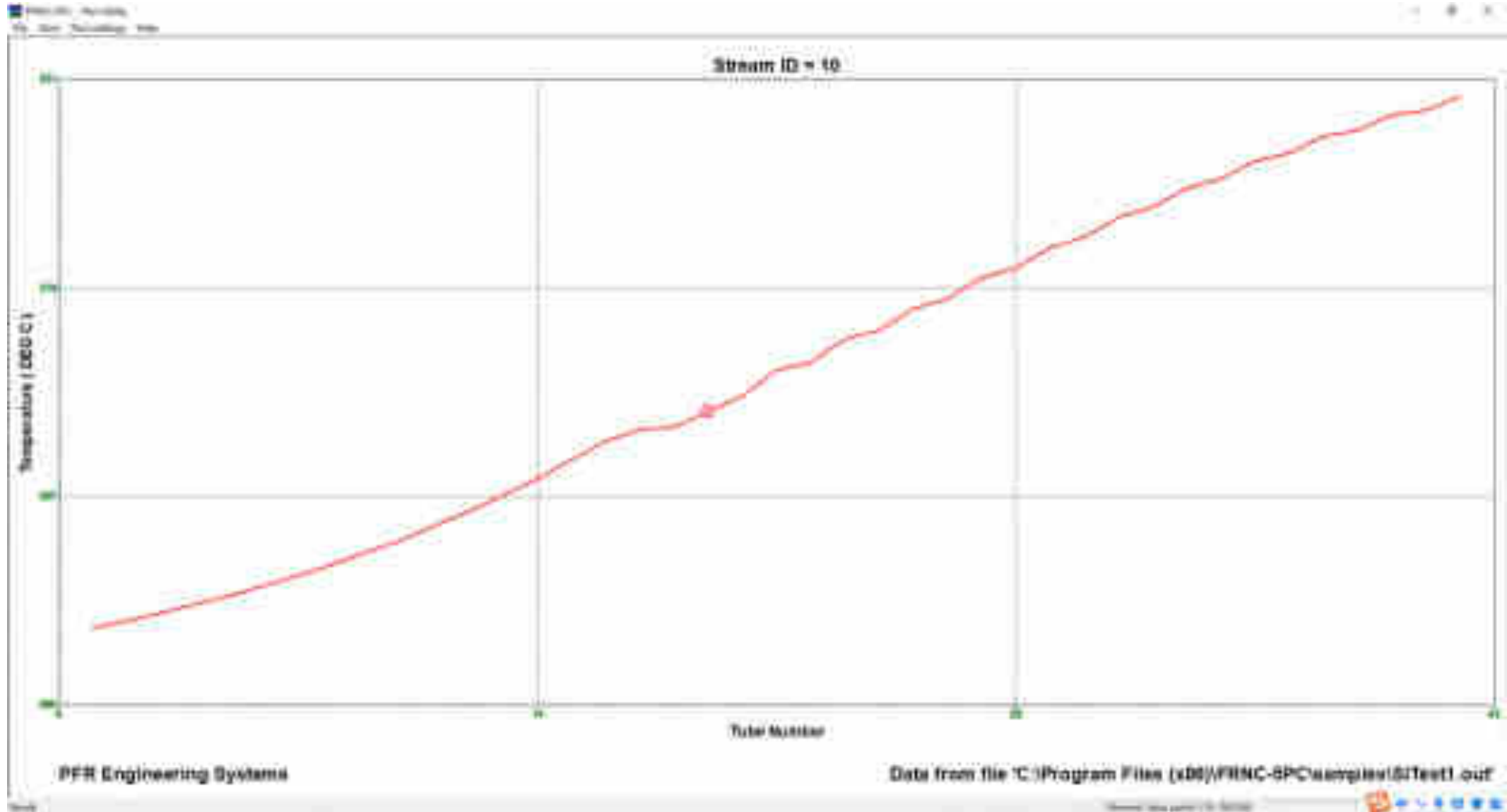
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---PAGE THREE---														
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25	25	100	100.0	0.000	0.0	1000.0	100	100	100	1000.0	1000.0	1000.0	1000.0	1000.0
26	26	100	100.0	0.000	0.0	1000.0	100	100	100	1000.0	1000.0	1000.0	1000.0	1000.0
27	27	100	100.0	0.000	0.0	1000.0	100	100	100	1000.0	1000.0	1000.0	1000.0	1000.0
28	28	100	100.0	0.000	0.0	1000.0	100	100	100	1000.0	1000.0	1000.0	1000.0	1000.0
29	29	100	100.0	0.000	0.0	1000.0	100	100	100	1000.0	1000.0	1000.0	1000.0	1000.0
30	30	100	100.0	0.000	0.0	1000.0	100	100	100	1000.0	1000.0	1000.0	1000.0	1000.0

File Edit View Options Help

File Edit View Options Help

输出界面





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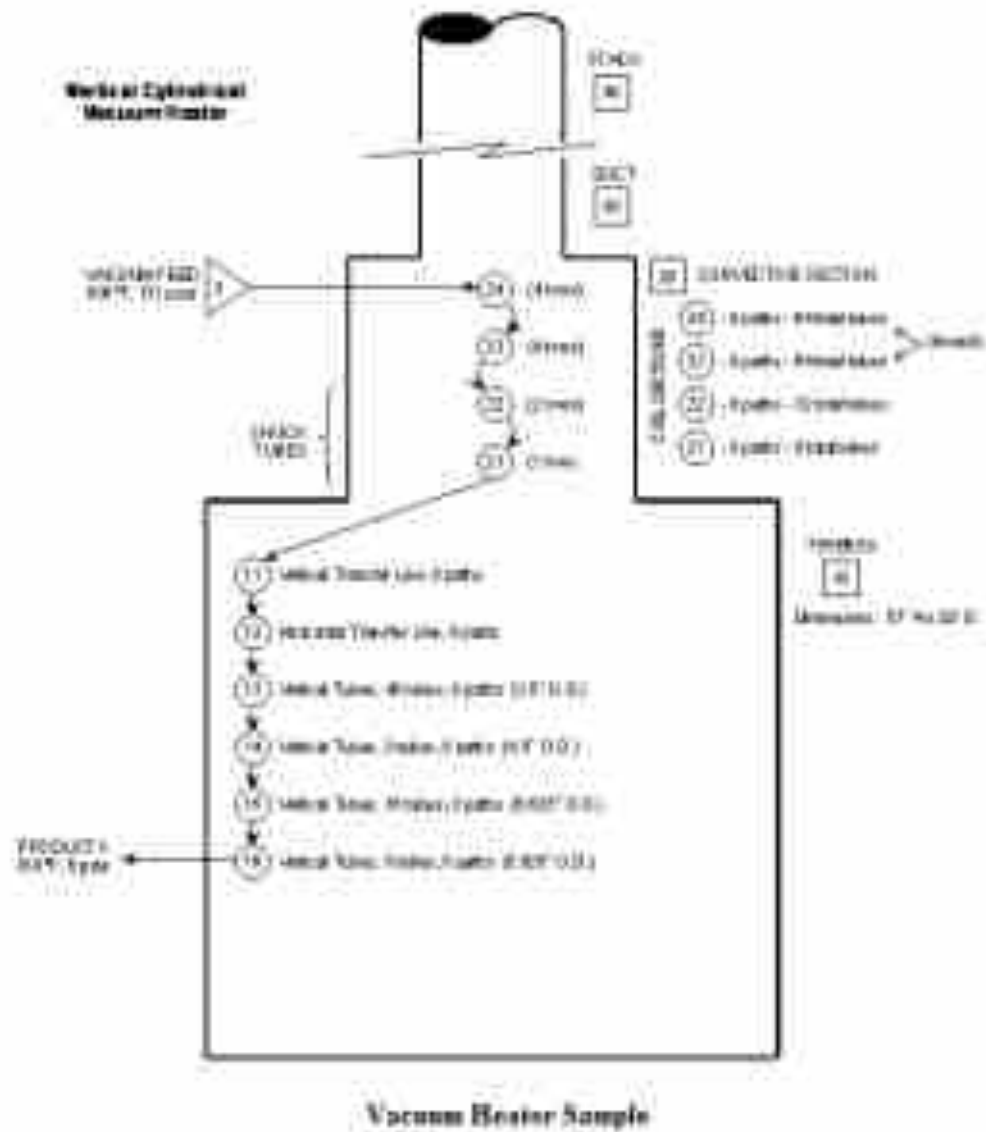
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Sample Case 3 - Vacuum Resid Heater

A vertical cylindrical heater (see Figure below) is being used to heat a vacuum resid feed to 810°F and an exit pressure of 6 psia. The heater is to be operated at only 30 percent of full design. The refinery's process group wants to investigate how the unit will operate and particularly determine the following:

- Draft
- Process side pressure drops and flow regimes
- Coking tendency of the resid at lower flow

Mechanical Data

The vertical heater tubes in the firebox increase in size from 3.5" OD (Coil 11) at inlet to a maximum of 8.625" OD at the process exit (Coil 16). The [TBP-CURVE](#) input was used to characterize the stream properties. The flue gas leaving the convection section enters a duct and then exits out the stack.

例 3 – 减压炉

采用圆筒炉（见左图）将常压渣油进料加热至810°F（432°C，出口压力为6 psia，0.041MPaa）。加热炉按30%的设计负荷运行，炼油厂的工艺小组想了解这种工况下的加热炉的运行状态，特别是以下内容：

- 抽力
- 管内物流的压降和流态
- 渣油在较低流量下的结焦趋势

机械参数

辐射室内的垂直炉管规格从入口处的3.5“外径（管组11）增加到工艺出口处的最大8.625”外径（管组16）。采用TBP蒸馏曲线表征物流属性。烟气离开对流段20后进入烟道30，然后从烟囱40流出。

The screenshot displays a software interface with a project tree on the left, a parameter table in the center, and a 'Process Conditions' dialog box in the foreground.

Parameter Table:

Parameter	Value	Unit
Process stream ID number	40	
Is it connected with other process streams		
Process stream name		
Flow rate	1000	kg/h
Heat flow		
Heat transfer coefficient	10000	W/m ² ·K
Heat exchanger	100.00	
Heat transfer area	100.00	m ²
Heat transfer efficiency	0.80	
Temperature-weight factor		
Heat transfer area-weight factor		
Heat exchanger	100.00	
Heat transfer efficiency	0.80	
Temperature-weight factor		
Heat transfer area-weight factor		

Process Conditions Dialog Box:

Process Conditions: 40-40

Process stream ID number: 40

Temperature: 100.00 °C

Pressure: 1.00 bar

Flow rate: 1000 kg/h

Heat flow: 1000000 W

Heat transfer coefficient: 10000 W/m²·K

Heat exchanger: 100.00 m²

Heat transfer efficiency: 0.80

Temperature-weight factor: 1.00

Heat transfer area-weight factor: 1.00

Heat exchanger: 100.00 m²

Heat transfer efficiency: 0.80

Temperature-weight factor: 1.00

Heat transfer area-weight factor: 1.00

Buttons: OK, Cancel, Help

例5：重整四合一炉

左图所示的简化示意图显示了重整四合一炉的管组和四个并列的辐射室布置。

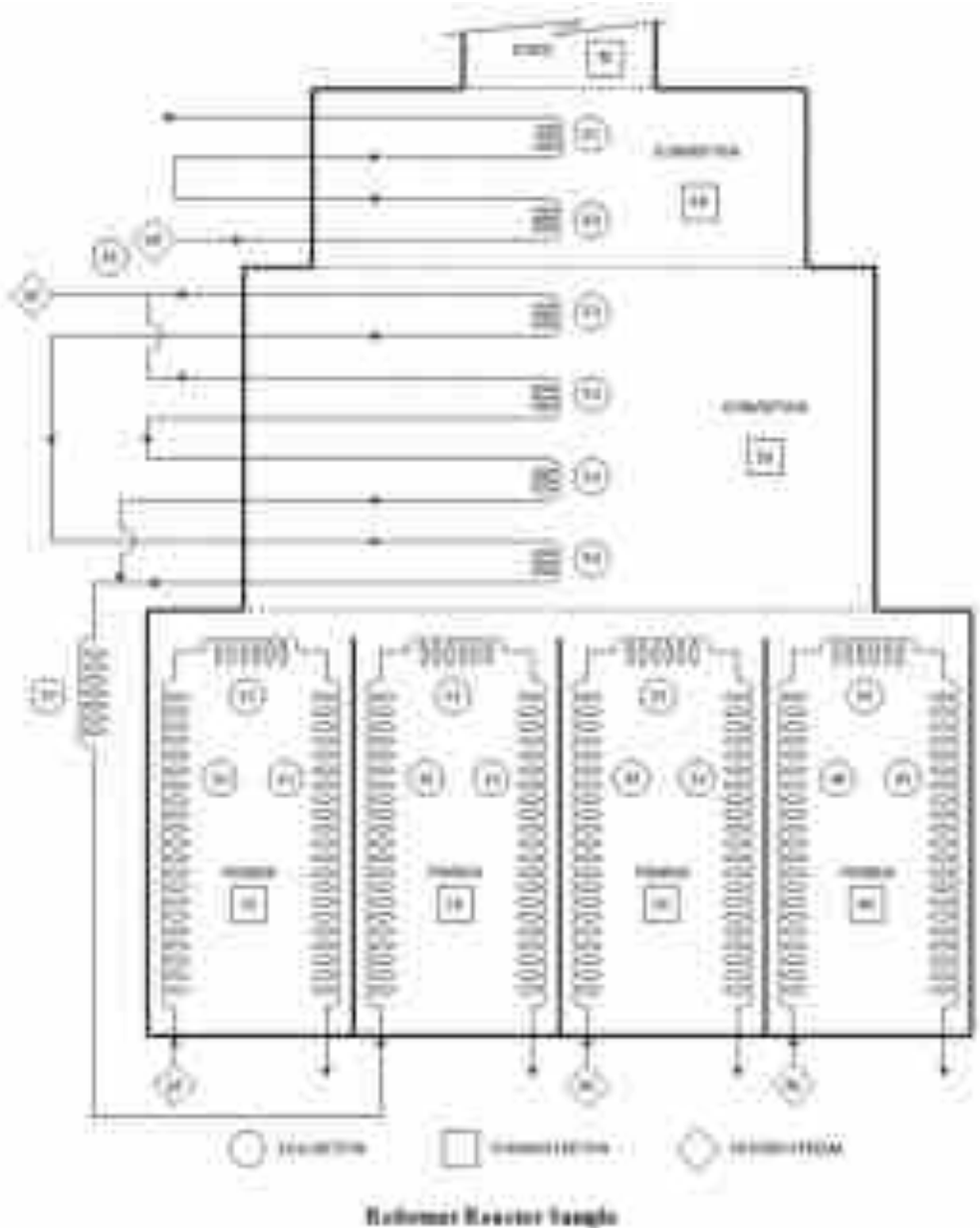
碳氢化合物、蒸汽和循环气体的混合物（物流ID=10）进入辐射室10，该辐射室内包含管组10、11和12。模型模拟了辐射室内的48根倒U型炉管。物流ID=10从辐射室10排出，进入重整反应器。

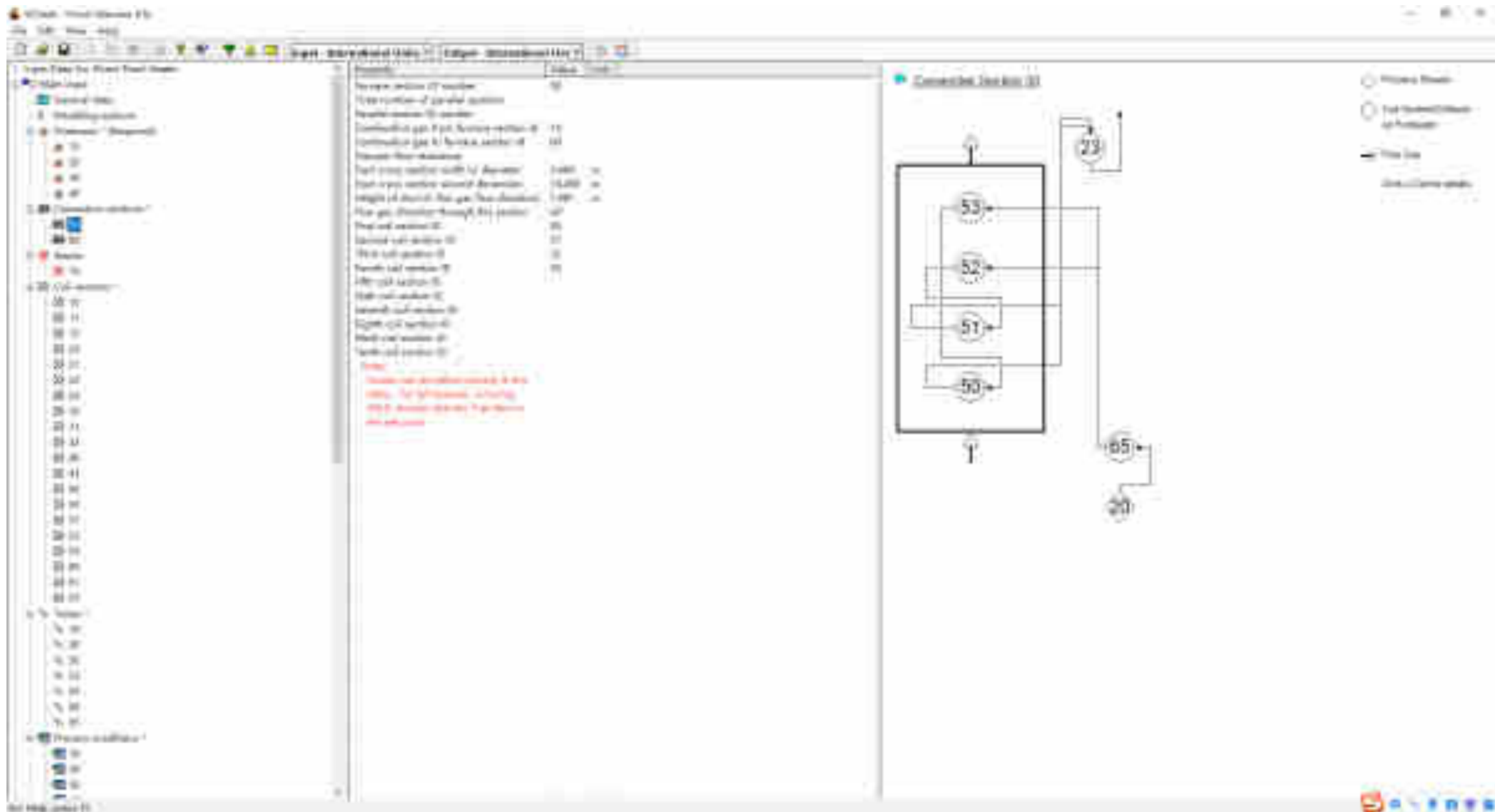
从第一个反应器出口开始，该物流（现在称为物流20）的温度降低，成分略有变化，重新进入四合一炉的对流段50。通过炉外转油线（管组65）物流20分为两股流，进入管组52与53。管组52与53每排都是16根翅片管。然后，物流20进入光管管组50和51，通过转油线（管组23）汇总后进入辐射室20。辐射室20内有管组20、21和22，模拟22根倒U型炉管。物流20从辐射室20出来后进入第二个重整反应器。

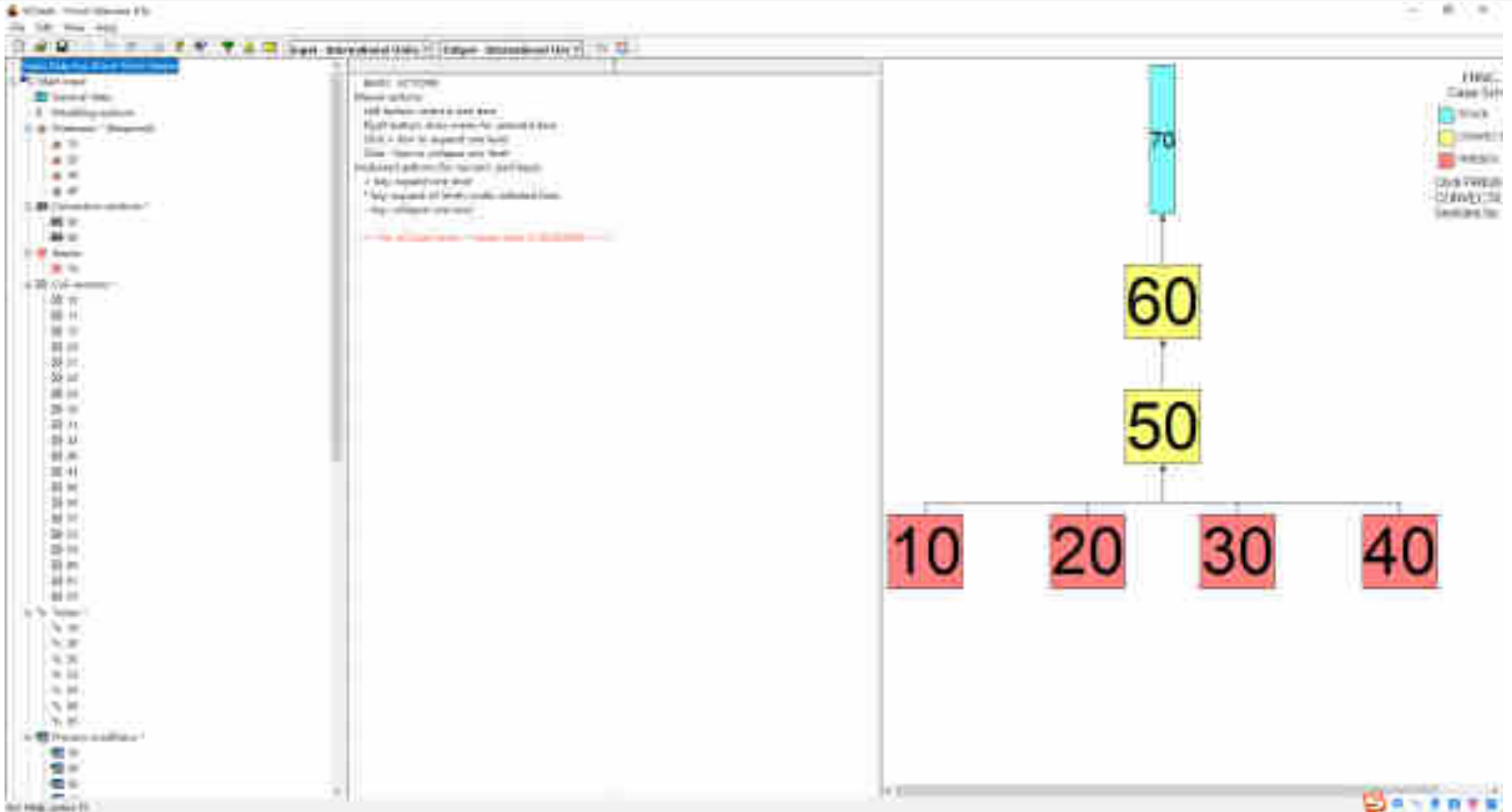
在第二个反应器之后，物流（现在ID=30）重新进入四合一炉辐射室30。该辐射室内有管组30、31和32，模拟38根倒U型炉管。物流30从加热炉出口到另一个重整反应器。

在第三个反应器之后，物流（现在ID=40）重新进入四合一炉辐射室40。该辐射室内有管组40、41和42，模拟20根倒U型炉管。物流40最终离开加热炉，进入最后一个重整反应器。

此外，对流段60中有一股气流（物流ID=60）流经管组60和61。这是对流段顶部的产汽段。







The screenshot displays the HSOFT software interface, which is used for creating and simulating electrical control systems. The interface is divided into several main sections:

- Project Tree (Left):** Shows the hierarchical structure of the project, including components like 'Control Panel', 'MOTORS', and 'RELAYS'.
- Parameter Table (Middle):** A table listing various parameters for the selected component. The table has columns for the parameter name, its value, and units. Below the table, there are red text annotations: 'Value of parameter is wrong', 'Value of parameter is wrong', and 'No parameter'.
- Schematic Diagram (Right):** A visual representation of the electrical control circuit. It shows a vertical stack of three circular components labeled '42', '41', and '40'. A separate component labeled '40' is shown below, connected to the main stack. The diagram is titled 'Control Panel 01'.

Parameter	Value	Unit
Number of phases of motor	4	
Number of poles of motor	4	
Number of phases of motor	3	
Control type	001	
Control type	1,4,7	s
Control type	1,4,8	s
Control type	1,5,5	s
Control type	1,5,6	s
Control type	1,5,7	s
Control type	1,5,8	s
Control type	1,5,9	s
Control type	1,5,10	s
Control type	1,5,11	s
Control type	1,5,12	s
Control type	1,5,13	s
Control type	1,5,14	s
Control type	1,5,15	s
Control type	1,5,16	s
Control type	1,5,17	s
Control type	1,5,18	s
Control type	1,5,19	s
Control type	1,5,20	s
Control type	1,5,21	s
Control type	1,5,22	s
Control type	1,5,23	s
Control type	1,5,24	s
Control type	1,5,25	s
Control type	1,5,26	s
Control type	1,5,27	s
Control type	1,5,28	s
Control type	1,5,29	s
Control type	1,5,30	s
Control type	1,5,31	s
Control type	1,5,32	s
Control type	1,5,33	s
Control type	1,5,34	s
Control type	1,5,35	s
Control type	1,5,36	s
Control type	1,5,37	s
Control type	1,5,38	s
Control type	1,5,39	s
Control type	1,5,40	s
Control type	1,5,41	s
Control type	1,5,42	s
Control type	1,5,43	s
Control type	1,5,44	s
Control type	1,5,45	s
Control type	1,5,46	s
Control type	1,5,47	s
Control type	1,5,48	s
Control type	1,5,49	s
Control type	1,5,50	s
Control type	1,5,51	s
Control type	1,5,52	s
Control type	1,5,53	s
Control type	1,5,54	s
Control type	1,5,55	s
Control type	1,5,56	s
Control type	1,5,57	s
Control type	1,5,58	s
Control type	1,5,59	s
Control type	1,5,60	s
Control type	1,5,61	s
Control type	1,5,62	s
Control type	1,5,63	s
Control type	1,5,64	s
Control type	1,5,65	s
Control type	1,5,66	s
Control type	1,5,67	s
Control type	1,5,68	s
Control type	1,5,69	s
Control type	1,5,70	s
Control type	1,5,71	s
Control type	1,5,72	s
Control type	1,5,73	s
Control type	1,5,74	s
Control type	1,5,75	s
Control type	1,5,76	s
Control type	1,5,77	s
Control type	1,5,78	s
Control type	1,5,79	s
Control type	1,5,80	s
Control type	1,5,81	s
Control type	1,5,82	s
Control type	1,5,83	s
Control type	1,5,84	s
Control type	1,5,85	s
Control type	1,5,86	s
Control type	1,5,87	s
Control type	1,5,88	s
Control type	1,5,89	s
Control type	1,5,90	s
Control type	1,5,91	s
Control type	1,5,92	s
Control type	1,5,93	s
Control type	1,5,94	s
Control type	1,5,95	s
Control type	1,5,96	s
Control type	1,5,97	s
Control type	1,5,98	s
Control type	1,5,99	s
Control type	1,5,100	s



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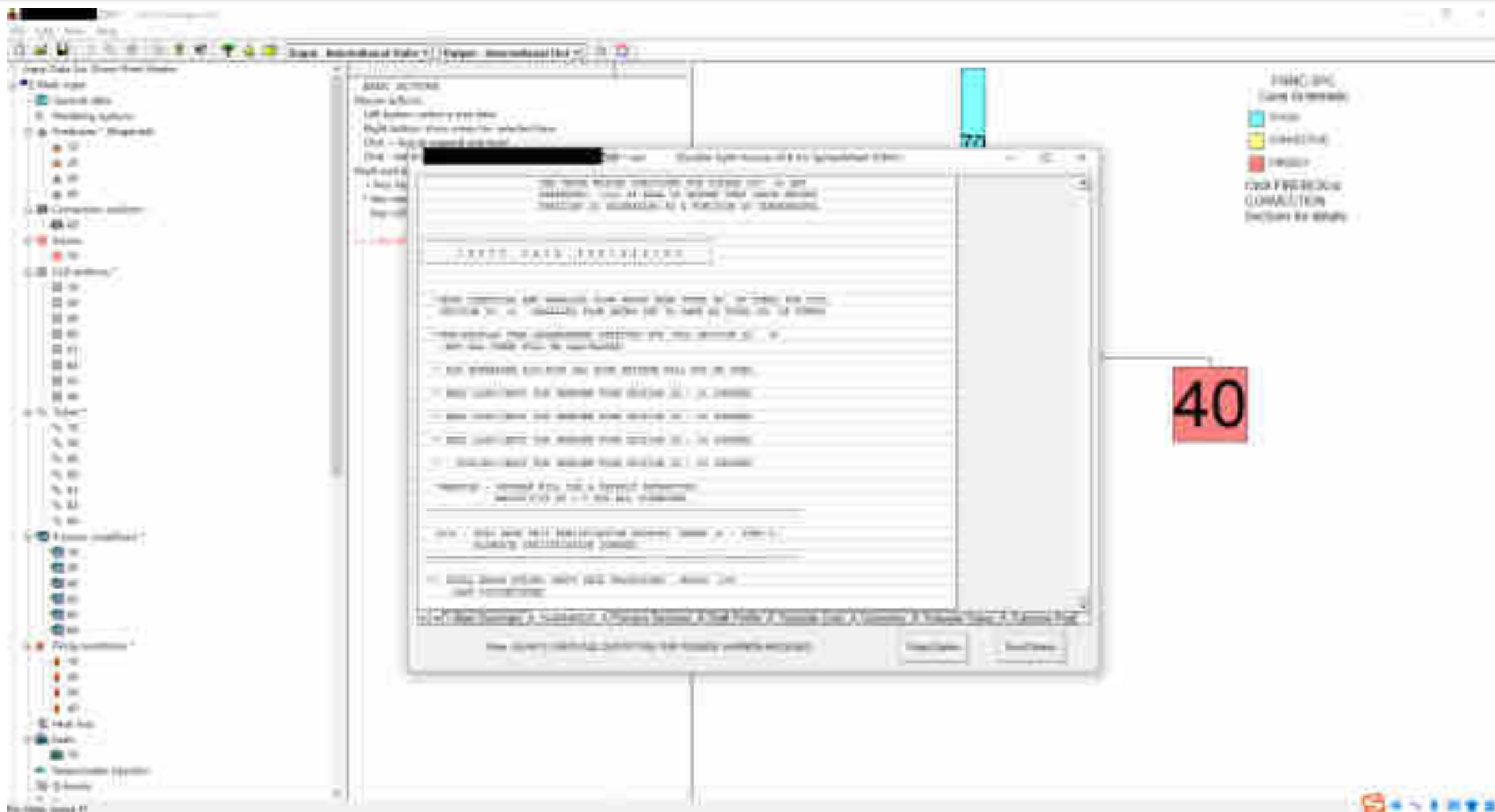
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用FR5See 进行错误代码内容检索



148 ERROR HAS DISCOVERED WHILE READING. (CHECK INPUT,
 ZERO-OF INPUT FILE HAS BEEN REACHED. CHECK AN END MARK,
 WHEN-CONVERSION OF (FUELING 2-HEAD) PRESSURE UNIT
 CALCULATION FOR API-NETVAL.
 149IN MANY FIELDS (-IT- 20), LOCATION = ***.
 150IN MANY INPUT VARIABLES (-IT- 20), LOCATION=***.
 151NUMERICAL TWO (00) FOR AN INTEGER, LOCATION=***.
 152TOTAL HEIGHT LENGTH ZERO. INPUT MAY HAVE BEEN TRUNCATED AT
 LOCATION = ***,
 153NOT BRIDGE INPUT FIELDS. LOCATION = ***.
 154NUMBER OF INPUT FIELDS DOES NOT DIFFER FROM REQUIRED NUMBER
 BY A MULTIPLE OF NINE.
 155INTEGER CONTAINS MORE THAN 4 DIGITS OR IS NEGATIVE.
 156NON-NUMERICAL CHARACTER AT LOCATION = ***,
 157ZERO NOT RECOGNIZED.
 158UNREAL COMPOSITION UNITS NOT CONSISTENT AND NOT CONVERTIBLE
 159MAXIMUM NUMBER OF COMPONENTS EXCEEDED.
 160COMPONENT TO STREAM 001 AND 1000 NOT ACCEPTABLE.
 161COMPONENT NOT STORED IN USUAL COMPONENT FILE.
 162FUELING COMPONENT HAS NOT BEEN DEFINED.
 163ONE OF THE COMPONENT FILES IS MISORGANIZED.
 164A. NUMBER OF COMPONENTS EXCEEDED DURING SLIDING. INPUT 4
 165LEADS "CORRECTION OF FIT" FACTOR ON THE 40 MIXTURE CASE.
 166ONE ERROR OCCURRED DURING PROCESSING OF COMPONENT AND STREAM
 167COMPOSITION INPUT DATA.
 168HEAT OF VAPORIZATION CALCULATION AT A TEMPERATURE AT OR
 169ABOVE CRITICAL. A ZERO VALUE WAS RETURNED.
 170CRITICAL COMPRESSIBILITY CALCULATED FOR A COMPONENT WITH A
 171BOILING POINT MORE THAN 1700 (DEG. F) OUTSIDE THE RANGE
 172FOR WHICH THE CORRELATION WAS CHECKED BY "REASONABLE
 173ESTIMATION".
 174CALCULATION OF LIQUID HEAT FLOW FOR A PSEUDO COMPONENT
 175MAY BE INADEQUATE. REFERENCE TEMPERATURE TOO CLOSE TO
 176CRITICAL. OR CRITICAL TEMPERATURE NOT AVAILABLE.
 177CORRECTION FACTOR CALCULATION OUTSIDE THE RANGE OF THE
 178CORRELATION. REDUCED NORMAL BOILING POINT IS LESS THAN
 1790.54 OR GREATER THAN 1.2.
 180HEAT OF VAPORIZATION COULD NOT BE CALCULATED. NORMAL
 181BOILING POINT EXCEEDS CRITICAL.
 182VISCOSITY PARAMETERS AT T-F W) CALCULATED WHILE THE
 183COMPONENT IS NOT A LIQUID AT THAT TEMPERATURE.

FRNC.ERR文件内容

241PROPERTY MISSING FROM PROPERTY GRID. OR IS MISSING IDENTIFY
 242AND/OR CRITICAL PRESSURE IS MISSING. POSSIBLY CAUSED BY THE
 243MANY STREAM CASES. (A STREAM CASE IS NOT ALLOWED FOR
 244STREAMS WITH ANOTHER STREAM'S PROPERTY GRID.)
 245UNEXPECTED STEAM INITIALTY OR FLOWRATE IN MIXING. FUELING,
 246STEAMING AND FUELING GAS TEMPERATURES CLOSE ENOUGH TO INTRINSIC
 247RANGES IN PEAK METAL TEMPERATURE CALCULATION. PEAK
 248TEMPERATURE MAY BE MORE THAN 15 DEGREES TOO HIGH.
 249OUTSIDE INSIDE WALL TEMPERATURE BELOW 500 (DEG. F). CHECK FUEL
 250GAS INLET POINT AND LOWEST INSIDE STACK TEMPERATURE.
 251BURNING RATE CALCULATION FAILED FOR A COIL SECTION. SEE
 252MONITOR CODE 04 OR 08 OR 14, ITEM 12 IF RELATIVE BURNING
 253RATE PROPORTION DECIDED.
 254UNREASONABLY HIGH BURNING ACTIVATION ENERGY GREATER THAN
 255100 (KCAL/MOLE).
 256NUMBER OF TUBES PER FACE IS A GOOD NUMBER 50. SUMMARY
 257INFORMATION STOPS AFTER 50 TUBES PER FACE STORAGE LIMITATION.
 258ALL TUBES HAVE BEEN CALCULATED. HOWEVER, TO GET PERCENT
 259OF ALL TUBES, DIVIDE THE COIL INTO MULTIPLE COILS.
 260BURNING RATE WILL BE IGNORED AND NOT USED FOR DETERMINING
 261INITIAL SPEED OF MIXING FUEL FLOW RATE BECAUSE IT IS
 262ACTUALLY LOWER THAN THE BURNING RATE OF THE OTHER FUEL.
 263WOULD NOT DETERMINE FLOW RATE OF MIXING FUEL. IN ORDER
 264TO ACHIEVE THE REQUIRED FIRED HEAT INPUT, ITS FLOW RATE
 265WOULD HAVE TO BE NEGATIVE. IN OTHER WORDS, THE OTHER
 266FUELS ALREADY SUPPLY MORE THAN ENOUGH FIRED HEAT.
 267OUTSIDE IS MANIFOLD INPUT. INLET OR EXIT MANIFOLD IS MISSING.
 268NO ADJUSTMENT WILL BE MADE FOR MANIFOLD PRESSURE DROP.
 269EVEN WITHOUT MANIFOLD.
 270ERROR IN MANIFOLD CALCULATION. NO ADJUSTMENT WILL BE MADE
 271FOR MANIFOLD PRESSURE DROP. EVEN WITHOUT MANIFOLD.
 272FATAL ERROR IN MANIFOLD CALCULATION. SOME COIL TERMINAL
 273PRESSURES MAY BE INCONSIST. EVEN WITHOUT MANIFOLD.
 274NO FUEL IN TUBES WAS SPECIFIED FOR THE FUELING. EACH
 275FUELING MUST HAVE FUEL COMPOSITION, EVEN IF IT IS ONLY A
 276NEGLIGIBLE AMOUNT.
 277NO PARTICULAR FUEL IS IS DEFINED BY MORE THAN ONE SHEET IS
 278OR BY BOTH A SHEET 12 AND A SHEET 13. PROGRAM WILL IGNORE
 279THE SHEET 12 AND USE THE FIRST SHEET 13 THAT WAS READ IN.
 280SOMEHOW SPECIFIC SPECIFIED TOO SMALL OR IS CALCULATED TOO
 281SMALL USE TO RUN-LEGAL TUBE BANK OPTION. ITEM 08 WITH
 282FING AND/OR FUELING THICKNESS IS HIGHER THAN THE SPACING



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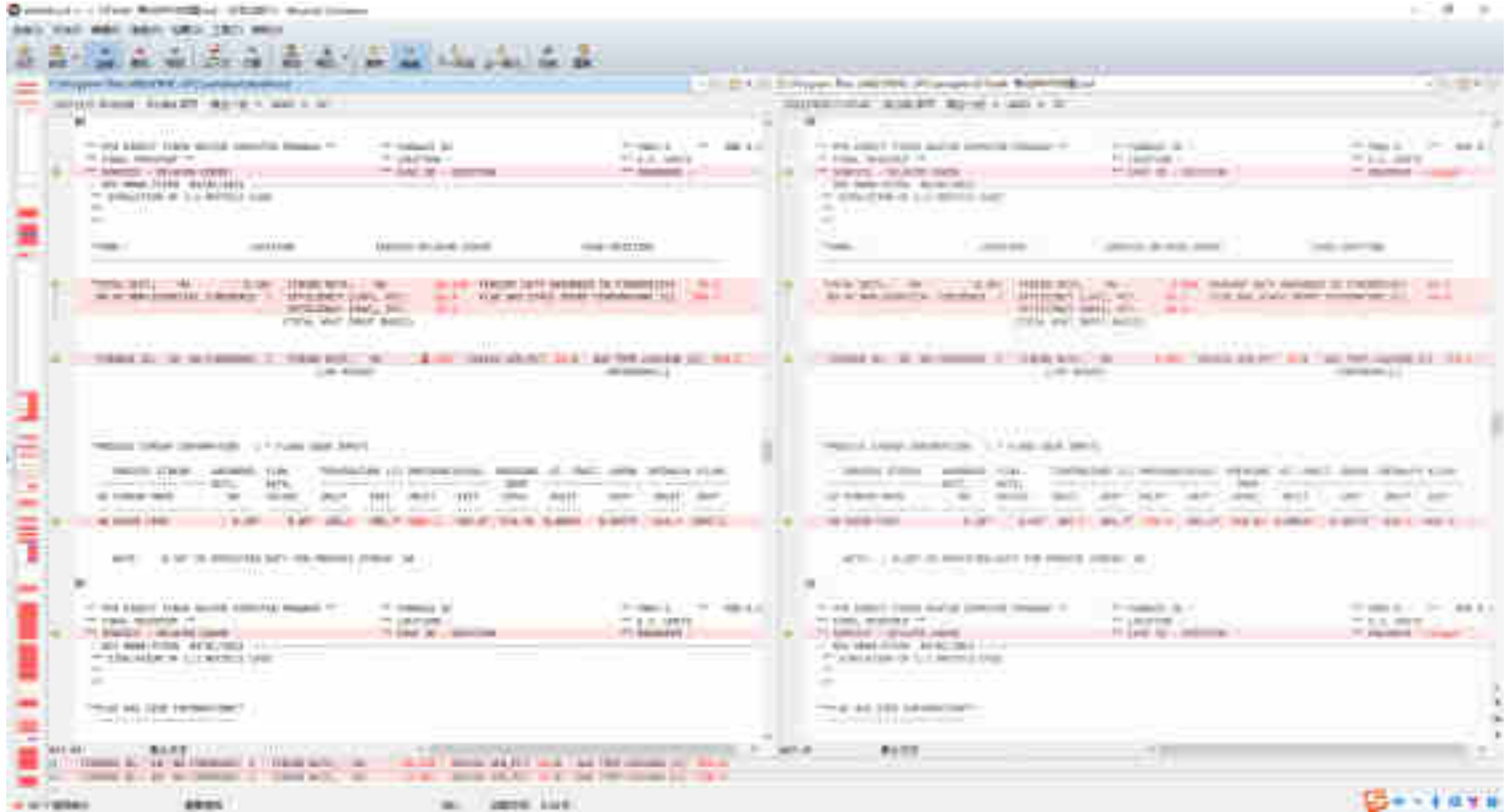
03

运行错误检查

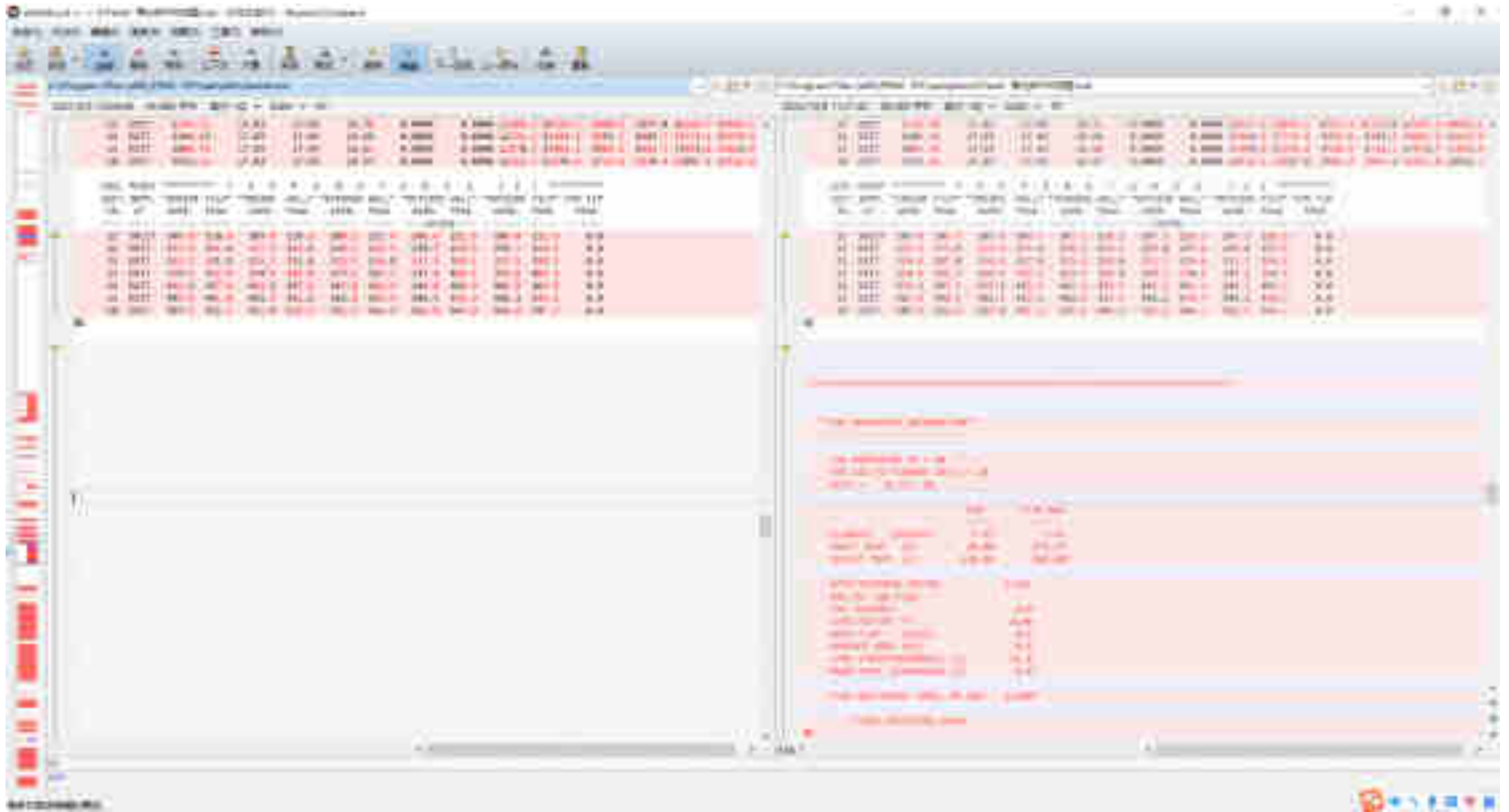
04

调试手段

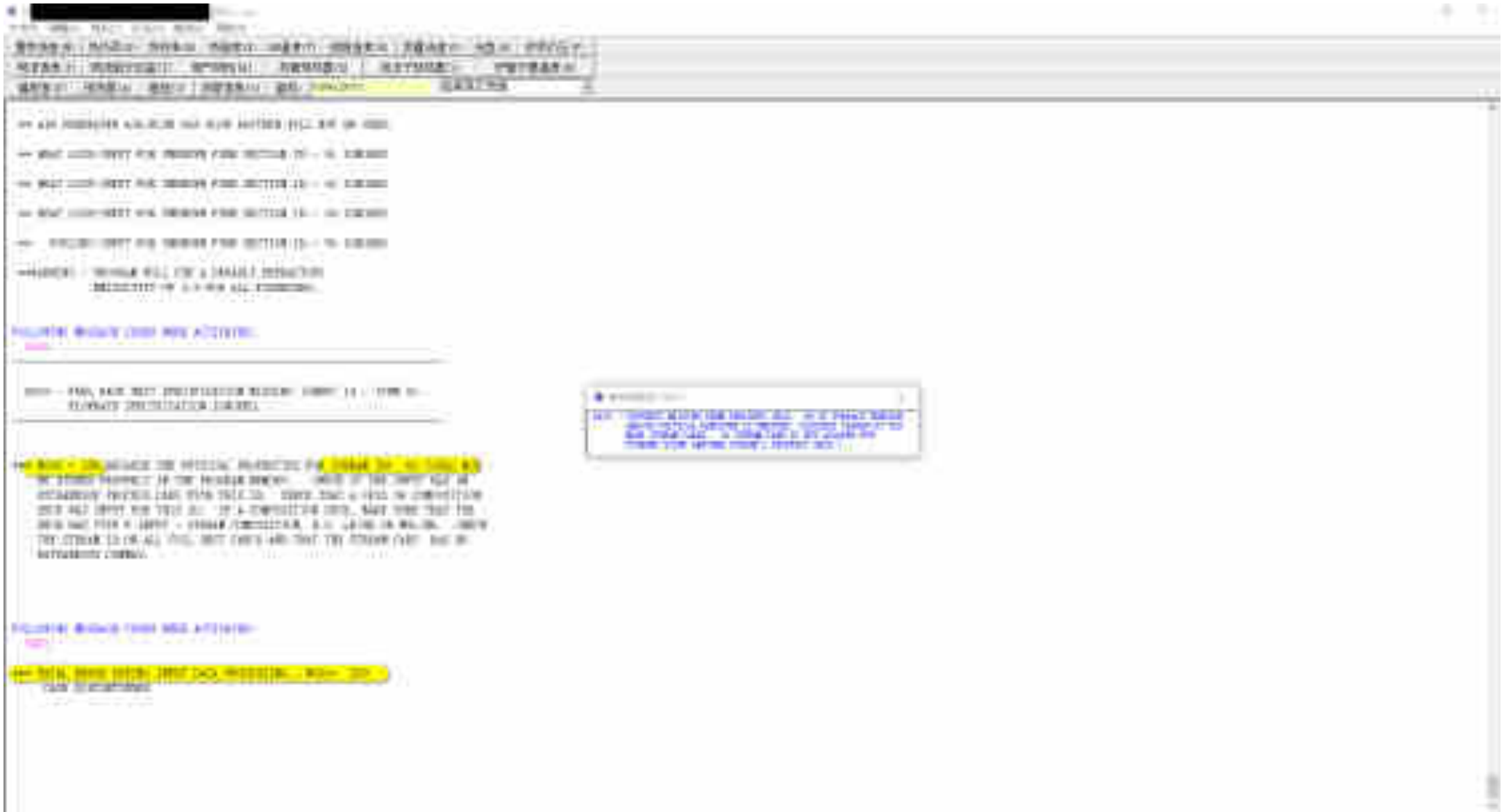
用Beyond Compare比较两个算例 计算结果差异



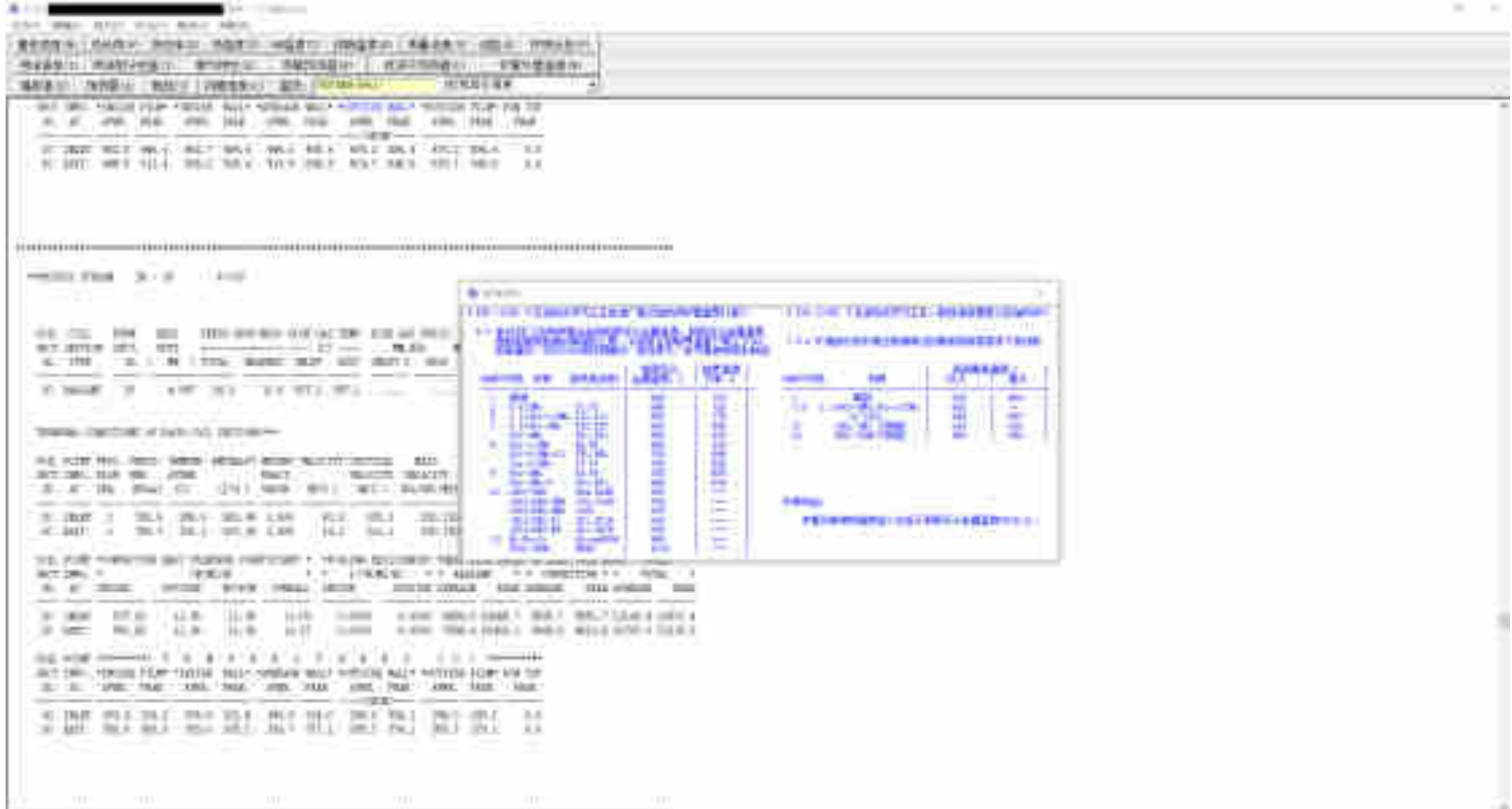
用Beyond Compare比较两个算例 计算结果差异



用FR5See 进行错误代码内容检索



用FR5See 进行管壁温度检查



用FR5See 进行物流组分检查

The screenshot displays the FR5See software interface. The main window shows a list of components with columns for '物料名称' (Material Name), '规格' (Specification), '单位' (Unit), and '数量' (Quantity). A red box highlights a specific component in the list. A red arrow points from this box to a detailed view window titled '物料详细属性' (Material Detailed Properties). This window shows a table of '物料组成' (Material Composition) with columns for '物料名称' (Material Name), '规格' (Specification), '单位' (Unit), and '数量' (Quantity). The detailed view shows a hierarchical structure of components, with the selected component's details expanded.

用FR5See 进行热强度检查

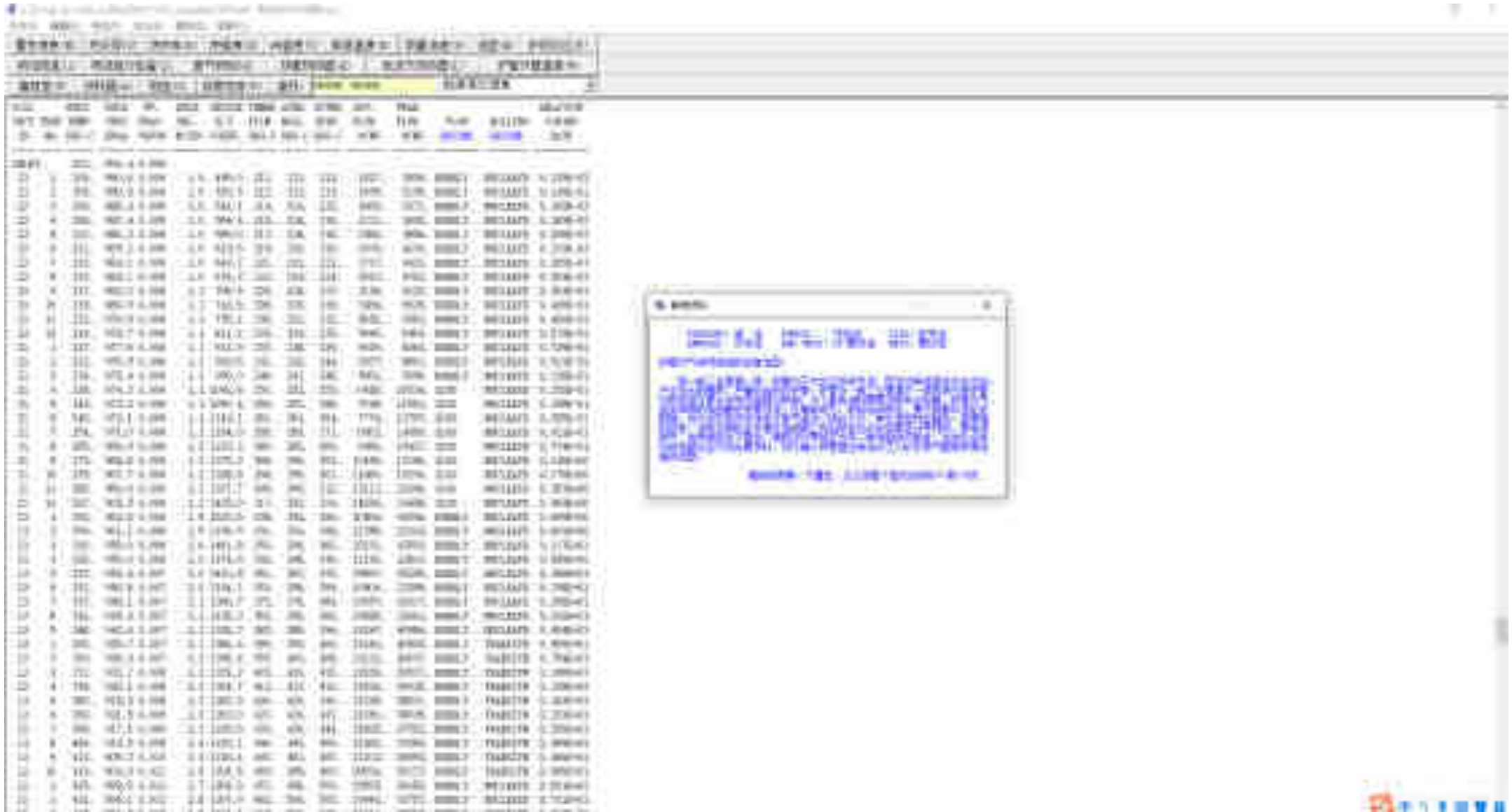
The screenshot displays the FR5See software interface with a detailed thermal stress analysis report. The report is organized into several sections:

- Material Properties:** Lists material parameters such as Young's Modulus (E), Poisson's Ratio (ν), and Coefficient of Thermal Expansion (α).
- Stress Distribution Data:** A large table showing stress components (σ_{xx}, σ_{yy}, σ_{zz}, τ_{xy}, τ_{yz}, τ_{xz}) across various nodes or elements. The data is presented in a grid format with multiple columns for different stress components.
- Summary Table:** A table at the bottom right summarizing key results, including maximum and minimum values for stress and temperature.

Summary Table Data:

Item	Max	Min
Max. Temperature (°C)	100	25
Max. Stress (MPa)	100	25
Max. Strain (%)	0.001	0.001
Max. Displacement (mm)	0.001	0.001
Max. Temperature (°C)	100	25
Max. Stress (MPa)	100	25
Max. Strain (%)	0.001	0.001
Max. Displacement (mm)	0.001	0.001

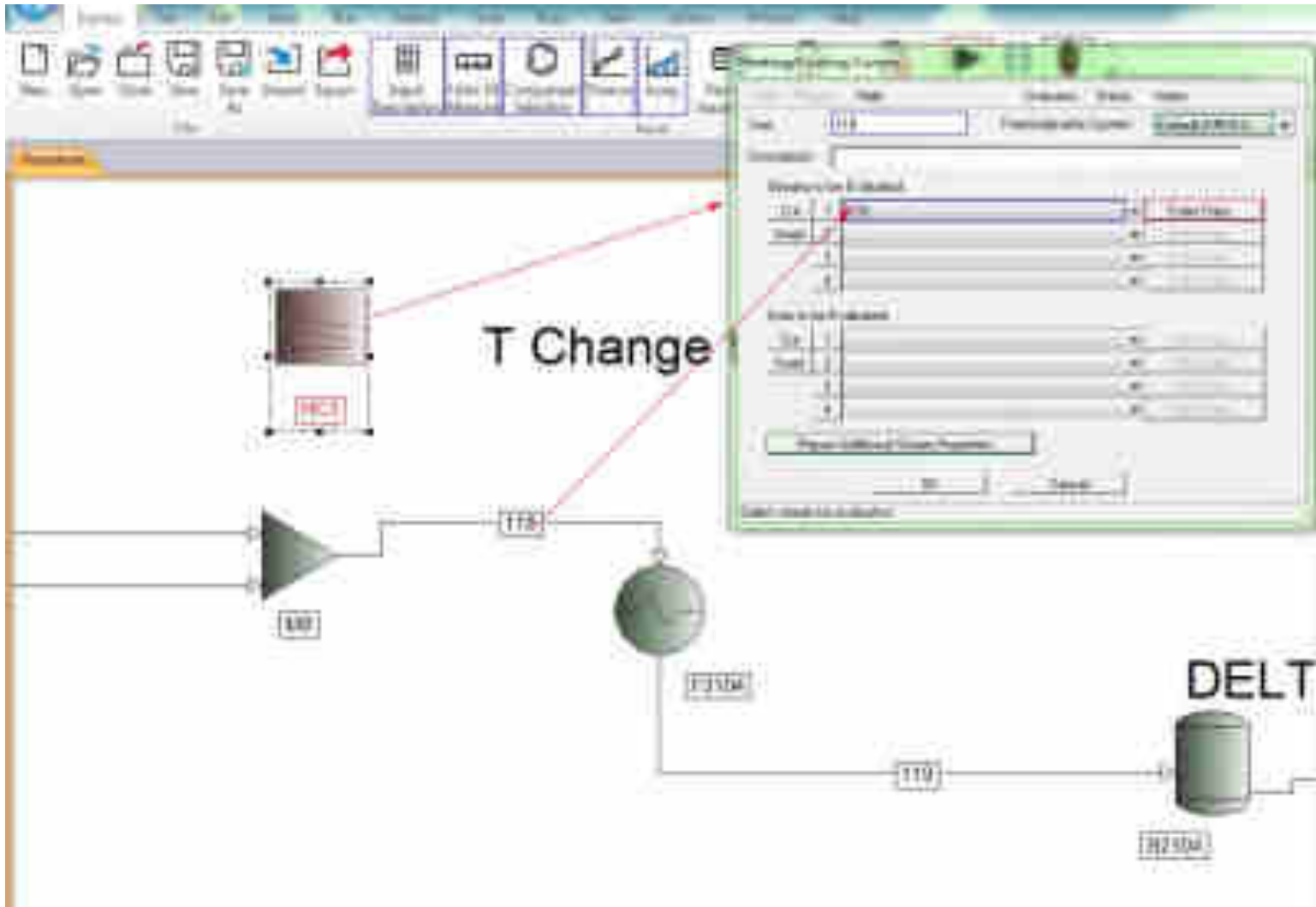
用FR5See 进行流型检查



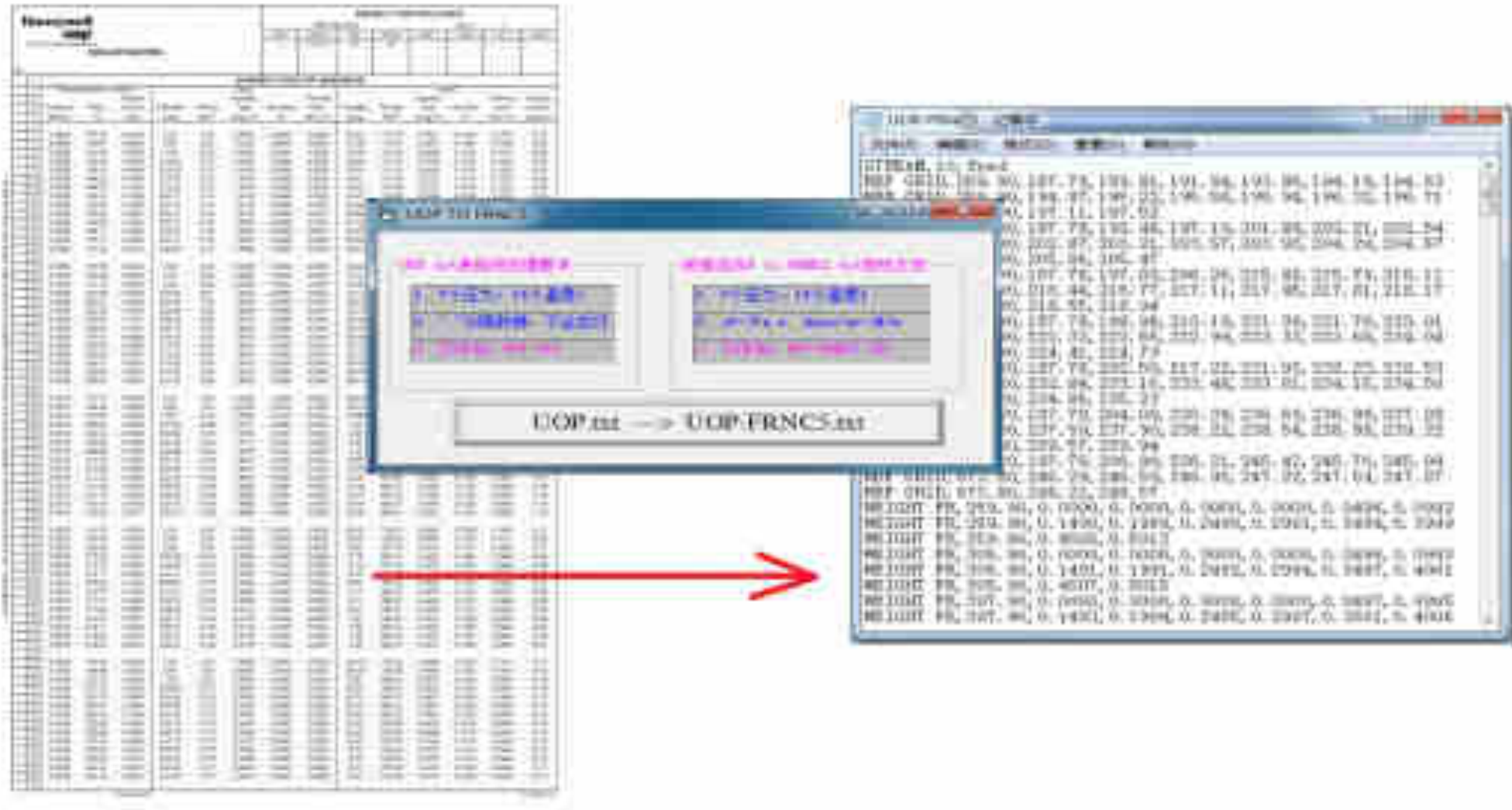
用FR5See 进行热管空气预热器设计



借助 PRO II 生成物性网格数据




借助UOP to FRNC5 帮助输入PDF格式物性网格数据



物性网格输入

Physical property grid input - ID: 03

Identification (Grid definition) | Vapourization curve | Property grid | Critical pressure | Comments

Steps ID: 

Stream name:

To define the grid, use one of the following methods:

Method 1: (Manual Data Input) Start on the Grid definition Tab.

Method 2: (Input from a Process Simulator Output File)

Method 3: (Import from a Sweet PRAC 5 Property Grid)

Method 4: (Transfer TO or FROM PPR) (Excel Property Transfer Data)

Method 5: (Import a Baker-Hugh Transfer Platform file)

网上的中文操作指南

FRNC SPC工艺计算软件中文操作指南.doc-偷创意文档

<https://max.book118.com/html/2020/11/21/50441332130030100.shtml>

2020-11-21 石松江过程控制与检测工程 2011.5 页36页 工艺计算软件操作指南

FRNC SPC 2 软件操作 本指南由德国博世力士乐公司的一级经销商工艺计算软件 FRNC SPC

1.加热炉工艺计算软件frnc5使用入门-豆丁网

<https://www.docin.com/p-1511167005.html>

2016.3.20 FRNC SPC软件使用指南.1 软件: 本软件为本公司用于加热炉工艺计算的软件。本软件由德国博世力士乐公司开发, 本软件在行业内应用广泛, 且操作简单, 易于学习。本软件由德国博世力士乐公司开发, 本软件在行业内应用广泛, 且操作简单, 易于学习。

FRNC-SPC工艺计算软件中文操作指南_百度文库

<https://wenku.baidu.com/view/75109e0f900e051810ad1024...>

FRNC-SPC软件用于工艺计算, 其操作非常简单, 用户只需将数据输入到软件中, 即可得到计算结果。本软件的操作非常简单, 用户只需将数据输入到软件中, 即可得到计算结果。本软件的操作非常简单, 用户只需将数据输入到软件中, 即可得到计算结果。

火焰加热炉模拟软件FRNC-5介绍-豆丁网

<https://www.docin.com/p-640935149.html>

2013.4.4 本软件为德国博世力士乐公司开发, 用于加热炉工艺计算的软件。本软件由德国博世力士乐公司开发, 用于加热炉工艺计算的软件。本软件由德国博世力士乐公司开发, 用于加热炉工艺计算的软件。

1.加热炉工艺计算软件FRNC5使用入门.doc

<https://max.book118.com/html/2017/05/29/110071487.shtml>

2017.5.29 德国博世力士乐工艺计算软件FRNC-5使用入门 FRNC-5软件的操作与使用指南 本书是博世力士乐工艺计算软件 FRNC-5 使用入门 手册, 本书详细介绍了该软件的各个方面, 包括软件的安装、启动、操作、维护等。

(工艺技术)FRNC5PC工艺计算软件中文操作指南 (35页)

<https://max.book118.com/html/2020/06/29/7003041014002183.shtml>

2020.6.29 石松江过程控制与检测工程 2011.5 页36页 FRNC SPC软件操作指南 本指南由德国博世力士乐公司开发, 用于加热炉工艺计算的软件。本指南由德国博世力士乐公司开发, 用于加热炉工艺计算的软件。

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