

# 第12讲 Aspen中的管路模块

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# 本节主要内容

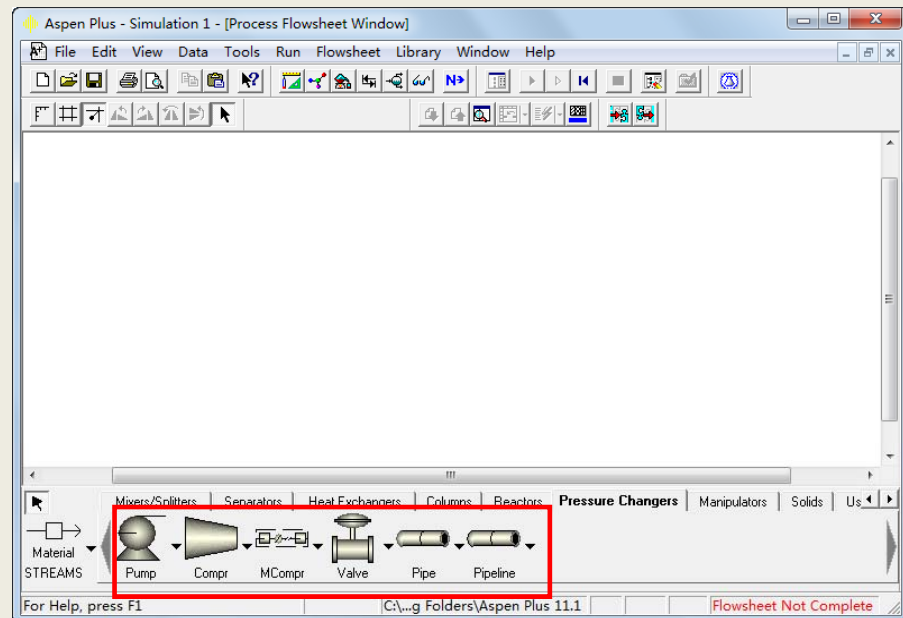
2

- ❖ **Pump**（泵）模型的介绍
- ❖ **Compressor**（压缩机）模型的介绍
- ❖ **Valve**（阀）模型的介绍
- ❖ **Pipe**（管段）和**Pipeline**（管线）的介绍
- ❖ 模拟实例

# 流体输送模型（Pressure Changers）的分类

3

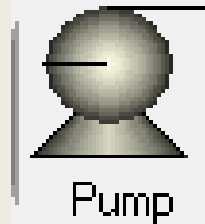
泵	<b>Pump</b>
压缩机	<b>Compr</b>
多级压缩机	<b>MComper</b>
阀门	<b>Valve</b>
管道	<b>Pipe</b>
管线	<b>Pipeline</b>



# Pump (泵) 模型

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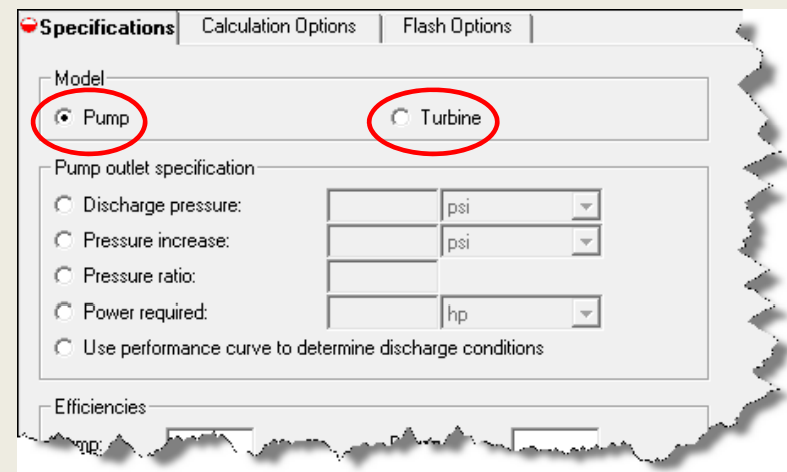
## ❖ Pump 泵模型



## ❖ Pump 模型用于模拟泵和水轮机两种单元设备

➤ 泵 ( Pump )

➤ 水轮机 ( Hydraulic Turbine )



# Pump——模型参数①

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❖ **Pump**模型有五种工作方式:

## 指定模型参数

- 出口压力 ( **discharge pressure** )
- 压力增量 ( **pressure increase** )
- 压力比率 ( **pressure ratio** )
- 所需功率 ( **power required** )
- 特性曲线 ( **use performance curve to determine discharge conditions** )

# Pump——模型参数②

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- ❖ 最简单的用法是指定出口压力（**Discharge pressure**），并给定泵的水力学效率（**Pump Efficiency**）和驱动机电效率（**Driver Efficiency**），计算得到出口流体状态和所需的轴功率和驱动机电功率。

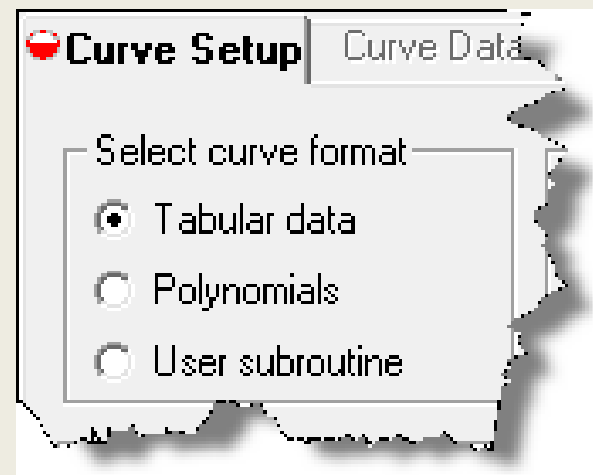
The screenshot shows a software dialog box with three tabs: 'Specifications', 'Calculation Options', and 'Flash Options'. The 'Specifications' tab is selected. It contains the following elements:

- Model:** Radio buttons for 'Pump' (selected) and 'Turbine'.
- Pump outlet specification:** Radio buttons for 'Discharge pressure:' (selected and highlighted with a red box), 'Pressure increase:', 'Pressure ratio:', 'Power required:', and 'Use performance curve to determine discharge conditions'. Each option has a corresponding input field and a unit dropdown menu (psi or hp).
- Efficiencies:** Input fields for 'Pump:' (highlighted with a red box) and 'Driver:' (highlighted with a red box).

# Pump——特性曲线①

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- ❖ 特性曲线 (**Performance curve**) 有三种输入方式:
  - 列表数据 (**Tabular Data**)
  - 多项式 (**Polynomials**)
  - 用户子程序 (**User Subroutines**)
- 列表数据是最常用的输入方式



# Pump——特性曲线②

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选择特性参数

**Curve Setup** | Curve Data | Efficiencies | NPSHR | Operating Specs

Select curve format

- Tabular data
- Polynomials
- User subroutine

Select performance and flow variables

Performance: Head

Flow variable:

Number of curves

- Single curve at operating speed
- Single curve at reference speed
- Multiple curves at different speeds

Number of curves: 1

Options

Interpolation method for tabular data: Hermite

选择特性曲线数目



# Pump——特性曲线③

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❖ 特性曲线的数目，有三个选项

➤ 操作转速下的单根曲线

**Single curve at operating speed**

➤ 参考转速下的单根曲线

**Single curve at reference speed**

➤ 不同转速下的多条去曲线

**Multiple curves at different speeds**

# Pump——特性曲线④

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## ❖ Curve Data 表单中输入数据

- 特性曲线变量的单位 **Units of curve variables**
- 每根曲线特性数据表如: **Head vs. flow tables**
- 每根曲线的对应转速 **Curve speeds**

Curve Setup **Curve Data** Efficiencies NPSHR Operating Specs

Units of curve variables

Head: [ ] Flow: [ cuft/hr ]

Head vs. flow tables

Curve No.: [ 1 ]

	Point	Head	Flow
*			

Curve speeds

Curve No.	Shaft Speed rpm
1	
2	
3	
*	

# Pump——特性曲线⑤

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❖ 在 **Efficiencies** 表单输入效率数据：

The screenshot shows the 'Efficiencies' tab of a software interface. At the top, there are tabs for 'Curve Setup', 'Curve Data', 'Efficiencies' (highlighted with a red box), 'NPSHR', and 'Operating Specs'. Below the tabs, there are sections for 'Units of curve variables', 'Efficiency vs. flow table', and 'Curve speeds'.

**Units of curve variables:**  
Efficiency: Fraction  
Flow: cuft/hr

**Efficiency vs. flow table:**  
Curve No.: 1

	Point	Efficiency	Flow
*			

**Curve speeds:**

	Curve No.	Shaft Speed rpm
	1	
	2	
	3	
*		

# Pump——特性曲线⑥

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❖ 当泵的操作转速与特性曲线的转速不同时，还需要输入操作转速数据

The screenshot shows a software interface with several tabs: 'Curve Setup' (checked), 'Curve Data', 'Efficiencies', 'NPSHR', and 'Operating Specs' (checked). The 'Operating Specs' tab is active and contains the following sections:

- Operating parameters:** A red box highlights this section, which includes:
  - Operating shaft speed: [ ] rpm
  - Reference shaft speed: [ ] rpm
  - Impeller diameter: [ ] ft
- Curve scaling factors:** A section with three input fields:
  - Performance curve: [ 1 ]
  - Efficiency curve: [ 1 ]
  - NPSH required: [ 1 ]
- Affinity law exponents:** A section with three input fields:
  - Head: [ 2 ]
  - Power: [ 3 ]
  - Efficiency: [ 1 ]

# Pump —NPSHR表

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- ❖ 设计泵的安装位置时，应核算“允许汽蚀余量”
- **NPSHR**（**Net Positive Suction Head Required**）
- **NPSHR**≈**10-Hs**
- **Hs**为允许吸上真空度

✓ Curve Setup | Curve Data | Efficiencies | **NPSHR** | Operating Specs

Units of curve variables:  
NPSH required: [ ] Flow variable: Vol-Flow  
Flow: cuft/hr

NPSH-required vs. flow table  
Curve No.: 1

Point	NPSHR	Flow
*		

Curve speeds

Curve No.	Shaft speed rpm
1	
2	
3	
*	

# Compressor（压缩机）模型

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## ❖ Compressor（压缩机）模型



## ❖ Compressor 模型用于模拟四种单元设备

- 多变离心压缩机（**Polytropic Centrifugal Compressor**）
- 多变正排量压缩机（**Polytropic Positive**）
- 等熵压缩机（**Isentropic Compressor**）
- 等熵汽轮机（**Isentropic Turbine**）

# Compr — 计算模型①

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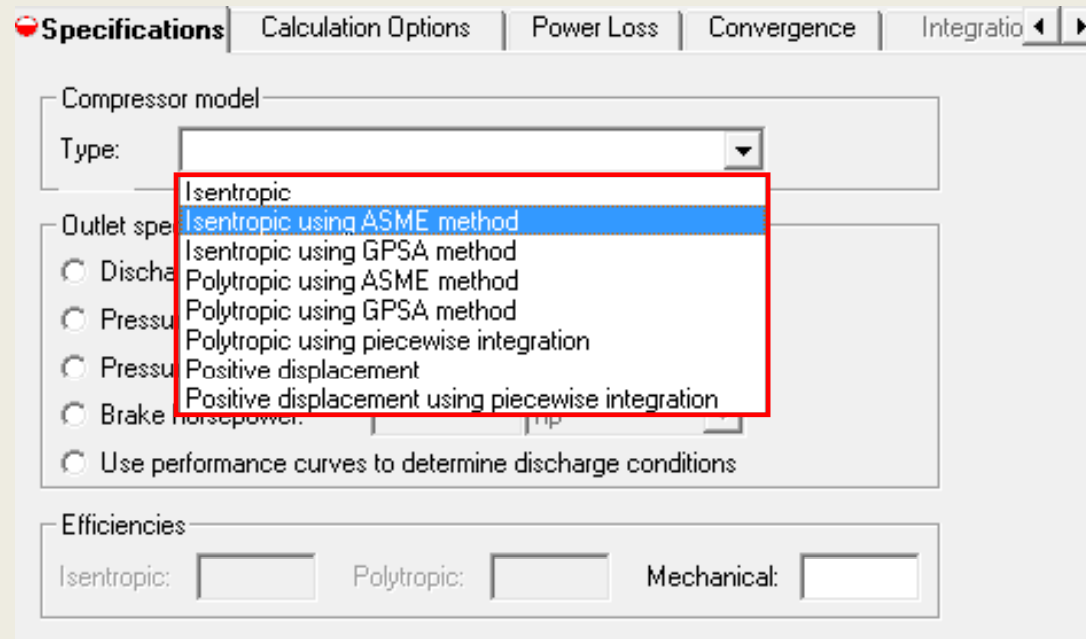
❖ **Compr**模块提供八种计算模型：

- 标准等熵模型 **Isentropic**
- ASME等熵模型 **Isentropic using ASME method**
- GPSA等熵模型 **Isentropic using GPSA method**
- ASME多变模型 **Polytropic using ASME method**
- GPSA多变模型 **Polytropic using GPSA method**
- 分片积分多变模型 **Polytropic using piecewise integration**
- 正排量模型 **Positive displacement**
- 分片积分正排量模型 **Positive displacement using piecewise integration**

# Compr — 计算模型②

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❖ 八种计算模型如图：





# Compr —模型参数①

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❖ **Compr**模型有五种工作方式：

## 指定模型参数

- 排出压力
- 压力增量
- 压力比率
- 所需功率
- 特性曲线

Specifications | Calculation Options | Power Loss | Convergence | Integratio

Compressor model  
Type: Isentropic using ASME method

Outlet specification

- Discharge pressure: [ ] psi
- Pressure change: [ ] psi
- Pressure ratio: [ ]
- Brake horsepower: [ ] hp
- Use performance curves to determine discharge conditions

Efficiencies  
Isentropic: [ ] Polytropic: [ ] Mechanical: [ ]

# Compr —效率

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❖ **Compr**模型有三种效率:

➤ 等熵效率 **Isentropic Efficiency**

➤ 多变效率 **Polytropic Efficiency**

➤ 机械效率 **Mechanical Efficiency**

Specifications | Calculation Options | Power Loss | Convergence | Integration

Compressor model  
Type: [ ]

Outlet specification  
 Discharge pressure: [ ] psi  
 Pressure change: [ ] psi  
 Pressure ratio: [ ]  
 Brake horsepower: [ ] hp  
 Use performance curves to determine discharge conditions

Efficiencies  
 Isentropic:  Polytropic:  Mechanical:

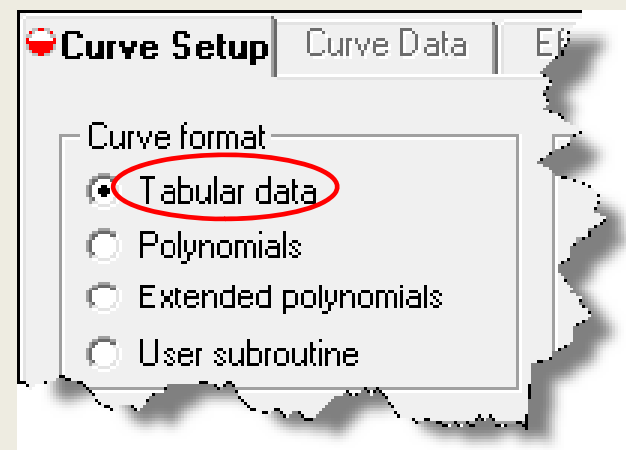
# Compr — 特性曲线

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❖ 压缩机也用特性曲线表征其工作性能

特性曲线有四种输入方式：

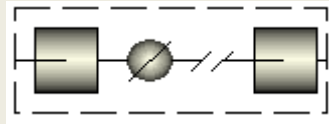
- 列表数据 **Tabular Data**
  - 多项式 **Polynomials**
  - 扩展多项式 **Extended Polynomials**
  - 用户子程序 **User Subroutines**
- 列表数据是常用的输入方式



# MCompr多级压缩机模型

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❖ **MCompr**模型:



**MCompr**模型用于模拟三种单元设备:

- 多级多变压缩机 ( **Multi-stage Polytropic Compressor** )
- 多级正排量压缩机 ( **Multi-stage Positive Displacement Compressor** )
- 多级等熵压缩机 ( **Multi-stage Isentropic Compressor** )

# MCompr —模型参数①

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❖ **MCompr**的模型参数有：

➤ 级数（**Number of stages**）

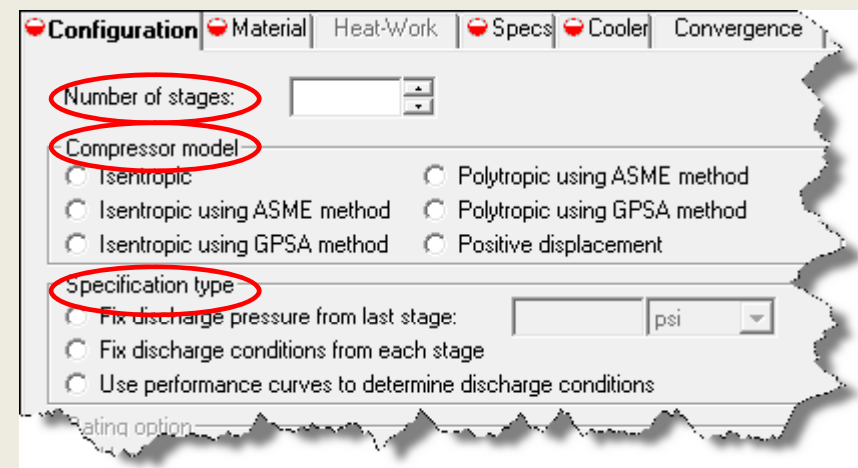
指定压缩机的级数

➤ 压缩机模型（**Compressor model**）

有六种计算模型供选用

➤ 设定方式（**Specification type**）

指定压缩机的工作方式



# MCompr — 模型参数②

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**MCompr**的设定方式与**Compr**模块有所不同：

指定末级排出压力

**(Fix discharge pressure from last stage)**

指定每级排出条件

**(Fix discharge conditions from each stage)**

用特性曲线确定排出条件

**(Use performance curves to determine discharge conditions)**

Specification type

Fix discharge pressure from last stage:  ps

Fix discharge conditions from each stage

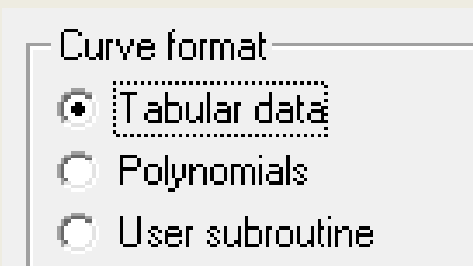
Use performance curves to determine discharge conditions

# MCompr —特性曲线①

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❖ **MCompr**特性曲线有三种输入方式:

- 列表数据 **Tabular Data**
- 多项式 **Polynomials**
- 用户子程序 **User Subroutines**



## MCompr —特性曲线②

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❖ 可以提供多张特性曲线表 (**Maps**)，每张表又可以有多条特性曲线。多级压缩机的每一级可以有多个叶轮 (**wheels**)，可以为每个叶轮选用不同的特性曲线表、叶轮直径。

The screenshot shows three panels of settings in the MCompr software interface. The first panel, titled "Wheel calculations", contains a checkbox for "Do wheel-to-wheel analysis" and a table with columns "Stage" and "No. of wheels". The second panel, titled "Number of maps", contains a numeric input field for "No. of performance maps". The third panel, titled "Number of curves per map", contains three radio button options: "Single curve at operating speed", "Single curve at reference speed", and "Multiple curves at different speeds", along with a numeric input field for "Number of curves".

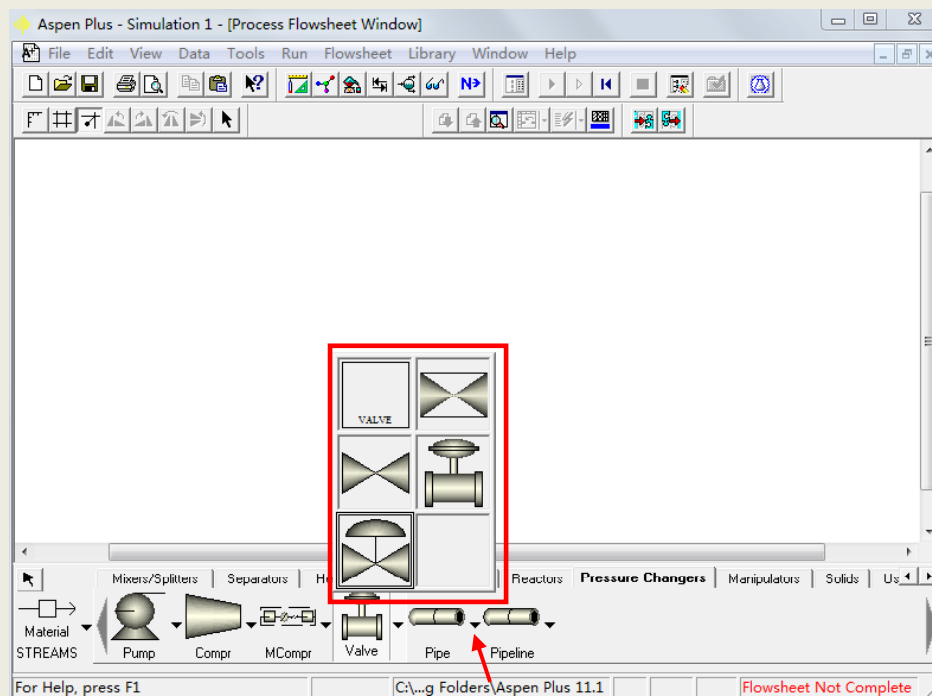
Stage	No. of wheels
*	



# Valve — 阀门模型①

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❖ **Valve** 用来调节流体流经管路时的压降:



# Valve — 阀门模型②

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❖ 阀门模型有三种应用方式:

➤ 绝热闪蒸到指定出口压力

**Adiabatic flash for specified outlet pressure**

➤ 对指定出口压力计算阀门流量系数

**Calculate valve flow coefficient for specified outlet pressure**

➤ 对指定阀门计算出口压力

**Calculate outlet pressure for specified valve**

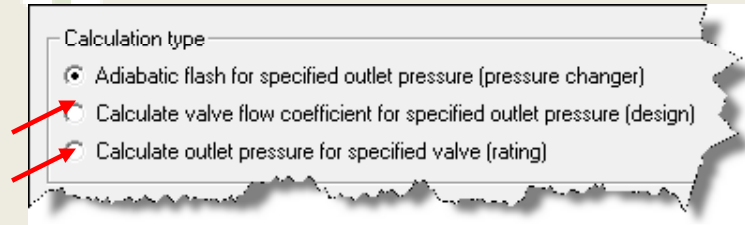
Calculation type

- Adiabatic flash for specified outlet pressure (pressure changer)
- Calculate valve flow coefficient for specified outlet pressure (design)
- Calculate outlet pressure for specified valve (rating)

# Valve — 阀门参数①

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❖ 当使用图中箭头所示的计算类型时：



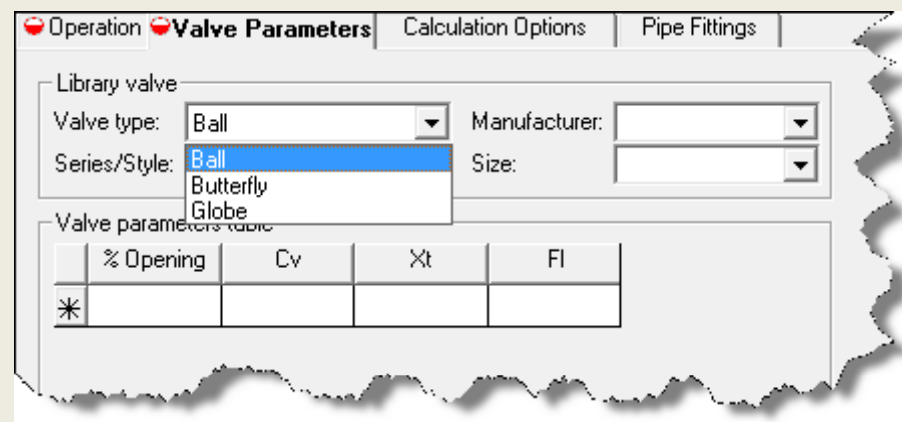
❖ 需输入以下参数：

➤ 阀门类型 (**Valve type**)：截止阀 (**Globe**)、球阀 (**Ball**)、蝶阀 (**Butterfly**)

➤ 厂家 (**Manufacturer**)

➤ 系列/规格 (**Series/Style**)：线性流量 (**linear flow**)、等百分比流量 (**equal percent flow**)

➤ 尺寸 (**Size**)：公称直径



# Valve — 阀门参数②

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The screenshot shows a software interface for configuring valve parameters. It features four tabs: "Operation", "Valve Parameters", "Calculation Options", and "Pipe Fittings". The "Valve Parameters" tab is active. The interface is divided into three main sections:

- Calculation type:** Three radio buttons are present. The third option, "Calculate outlet pressure for specified valve (rating)", is selected and highlighted with a dashed box.
- Pressure specification:** Two radio buttons are present. The second option, "Pressure drop", is selected. The units are set to "psi".
- Valve operating specification:** Two radio buttons are present. The first option, "% Opening", is selected and highlighted with a red box. A blue callout box labeled "阀门开度" (Valve opening) points to this field.
- Flash options:** A dropdown menu is set to "Vapor-Liquid". Below it, two fields are highlighted with red boxes: "Maximum iterations" (set to 30) and "Error tolerance" (set to 0.0001). Blue callout boxes label these as "最大迭代次数" (Maximum number of iterations) and "容差" (Tolerance) respectively.

# Valve — 计算选项

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❖ 计算阀门小开度状态时计算选项的设置很重要

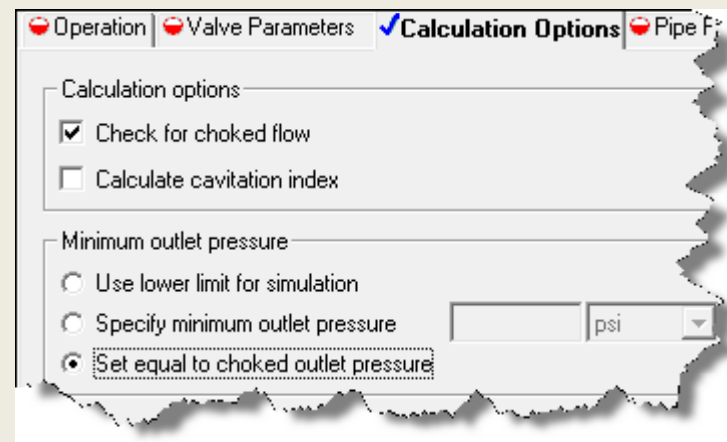
检查阻塞流动 (Check for choked flow)

计算空泡系数 (Calculate cavitation index)

设置最小出口压力等于阻塞压力

( Minimum outlet pressure:

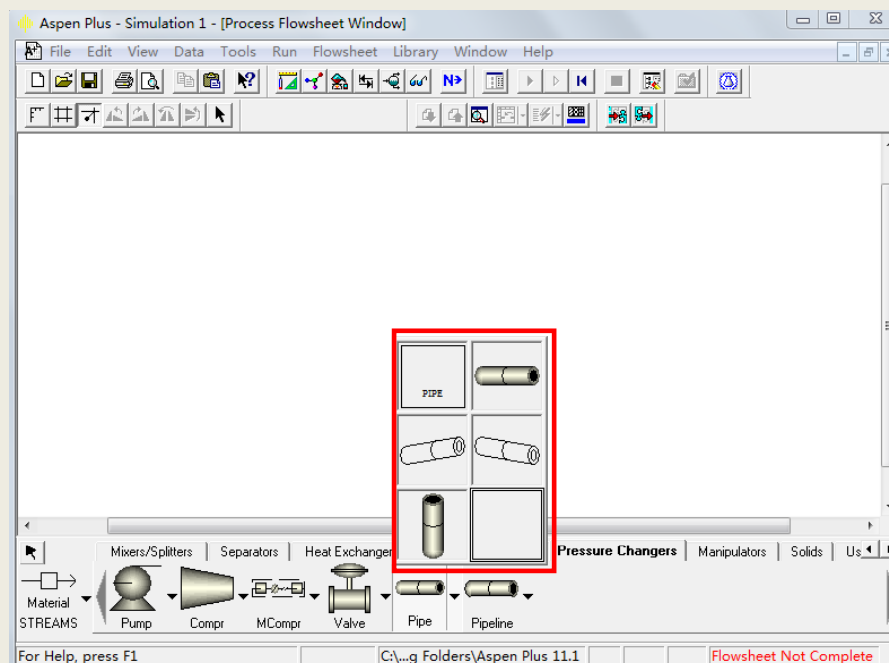
Set equal to choked outlet pressure )



# Pipe —管段模型①

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❖管段模型用于计算等直径、等坡度的一段管道的压降和传热量



# Pipe — 管段参数

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管道参数表

长度

直径

提升

粗糙度

The image shows a software dialog box titled 'Pipe Parameters' with four tabs: 'Pipe Parameters', 'Thermal Specification', 'Fittings', and 'Flash Options'. The 'Pipe Parameters' tab is active. It contains several sections: 'Length' with a 'Pipe length' input field and a unit dropdown set to 'ft'; 'Diameter' with radio buttons for 'Inner diameter', 'Use pipe schedules', and 'Compute using user subroutine', and an 'Inner diameter' input field with a unit dropdown set to 'ft'; 'Elevation' with radio buttons for 'Pipe rise' and 'Pipe angle', and input fields for 'Pipe rise' (set to 0) and 'Pipe angle' with unit dropdowns set to 'ft' and 'deg' respectively; 'Pipe schedules' with dropdowns for 'Material', 'Schedule', and 'Nom diameter'; and 'Options' with a 'Roughness' input field (set to 0.00015) and a unit dropdown set to 'ft', and an 'Erosional velocity coefficient' input field (set to 100). Blue callout boxes with Chinese text point to these fields: '长度' (Length) points to the 'Pipe length' field; '直径' (Diameter) points to the 'Inner diameter' field; '提升' (Elevation) points to the 'Pipe rise' field; and '粗糙度' (Roughness) points to the 'Roughness' field. A larger callout box at the top points to the entire dialog box with the text '管道参数表' (Pipe Parameters Table).

# Pipe —热参数设定

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- 恒温 **Constant temperature**
- 线性温度剖型 **Linear temperature profile**
- 绝热（零热负荷） **Adiabatic (zero duty)**
- 热衡算 **Perform energy balance**

热参数设定表

Pipe Parameters | **Thermal Specification** | Fittings | Flash Options

Thermal specification type

Constant temperature  
 Linear temperature profile  
 Adiabatic (zero duty)  
 Perform energy balance

Outlet temperature: [ ] F

Include energy balance parameters  
 Include heat flux

Energy balance parameters

Inlet ambient temperature: [ ] F  
Outlet ambient temperature: [ ] F  
Heat transfer coefficient: [ ] Btu/hr-sqft-R

Heat flux: [ ] Btu/hr-ft



# Pipe — 管件参数

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- ❖ 连接方式：法兰连接/焊接 **Flanged/Welded**，螺纹连接 **Screwed**
- ❖ 管件数量：闸阀 **Gate valves**，蝶阀 **Butterfly valves**，90度肘管 **Large 90 degree elbows**，直行三通 **Straight tees**，旁路三通 **Branched tee**

连接方式

管件数量

管件参数表单

其余当量长度

Pipe Parameters | Thermal Specification | **Fittings** | Flash Options

Connection type

Flanged welded

Screwed

Number of fittings

Gate valves: 0

Butterfly valves: 0

Large 90 degrees elbows: 0

Straight tees: 0

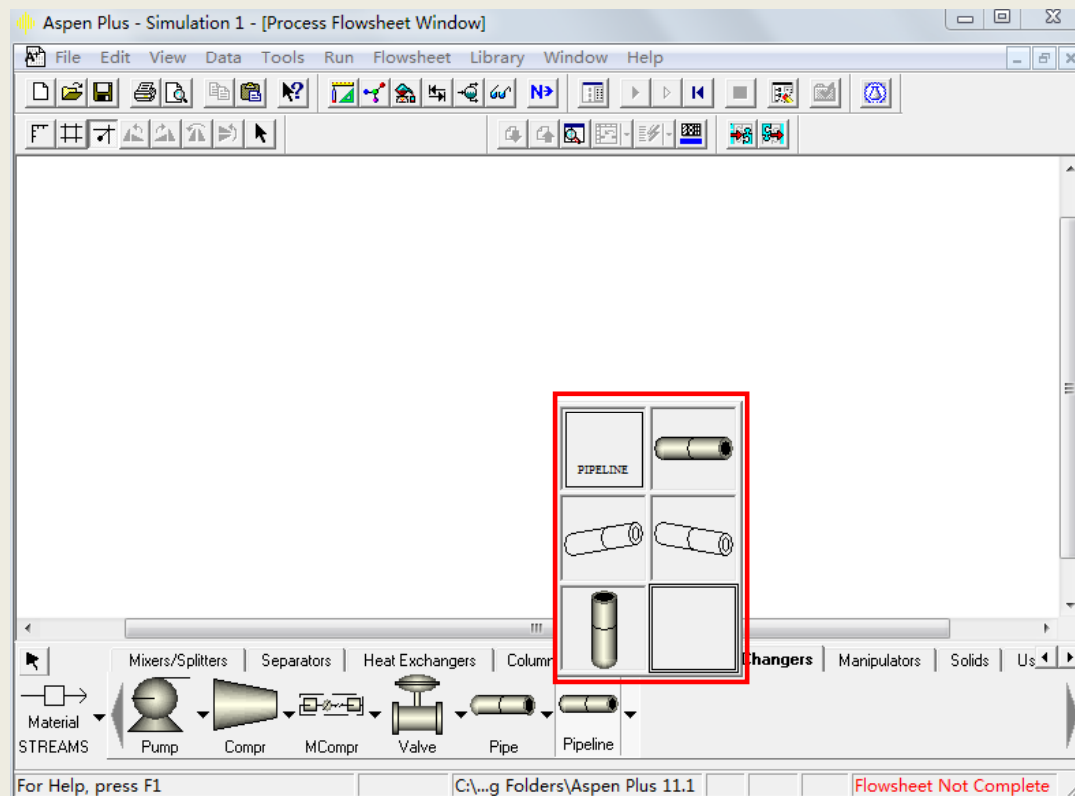
Branched tees: 0

Miscellaneous L/D: 0

# Pipeline — 管线模型

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管线模型用于计算由多段管道串联组成的一条管线的压降



# Pipeline — 管线参数①

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The image shows a software configuration window for pipeline parameters. The window has several tabs: Configuration, Connectivity, Methods, Property Grid, and Flash Options. The Configuration tab is active. It contains several sections with radio buttons and dropdown menus. Chinese callouts in blue boxes point to specific options:

- 计算方向** (Calculation direction) points to the "Calculate outlet pressure" radio button.
- 传热选项** (Thermal options) points to the "Specify temperature profile:" dropdown menu.
- 结构表** (Structure table) points to the "Connectivity" tab.
- 管段结构** (Segment structure) points to the "Enter segment length and angle" radio button.
- 物性计算** (Property calculations) points to the "Do flash at each step" radio button.
- 流动基准** (Flow basis) points to the "Use inlet stream flow" radio button.

The Configuration tab contains the following options:

- Calculation direction:**
  - Calculate outlet pressure
  - Calculate inlet pressure
- Thermal options:**
  - Do energy balance with surroundings
  - Specify temperature profile:
    - Constant temperature
- Segment geometry:**
  - Enter node coordinates
  - Enter segment length and angle
- Property calculations:**
  - Do flash at each step
  - Interpolate from property grid
- Pipeline flow basis:**
  - Use inlet stream flow
  - Reference outlet stream flow
- Inlet conditions:**
  - Pressure: [ ] psi
  - Temperature: [ ] F

## Pipeline — 管线参数②

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单击**NEW**:

连接状态表

Configuration **Connectivity** Methods Property Grid Flash Options

Segment summary

ID	In Node	Out Node	Diameter		Status
1				ft	Incomplete

New... Edit Delete

## Pipeline — 管线参数③

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弹出如图管段数据（**Segment data**）对话框：

在此对话框中逐段输入每  
管段的**长度、角度、直径、  
粗糙度**，或者**节点坐标、直  
径、粗糙度**。

Segment No.  Inlet node:  Outlet node:

Node parameters

	Inlet node		Outlet node	
Fluid temp:	<input type="text"/>	<input type="text" value="F"/>	<input type="text"/>	<input type="text" value="F"/>
C-Erosion:	<input type="text" value="100"/>	<input type="text"/>	<input type="text" value="100"/>	<input type="text"/>

Segment parameters

Length:	<input type="text"/>	<input type="text" value="ft"/>	Angle:	<input type="text" value="0"/>	<input type="text" value="deg"/>
Diameter:	<input type="text"/>	<input type="text" value="ft"/>	Annular OD:	<input type="text"/>	<input type="text" value="ft"/>
Roughness:	<input type="text" value="0.00015"/>	<input type="text" value="ft"/>	Efficiency:	<input type="text" value="1"/>	<input type="text"/>

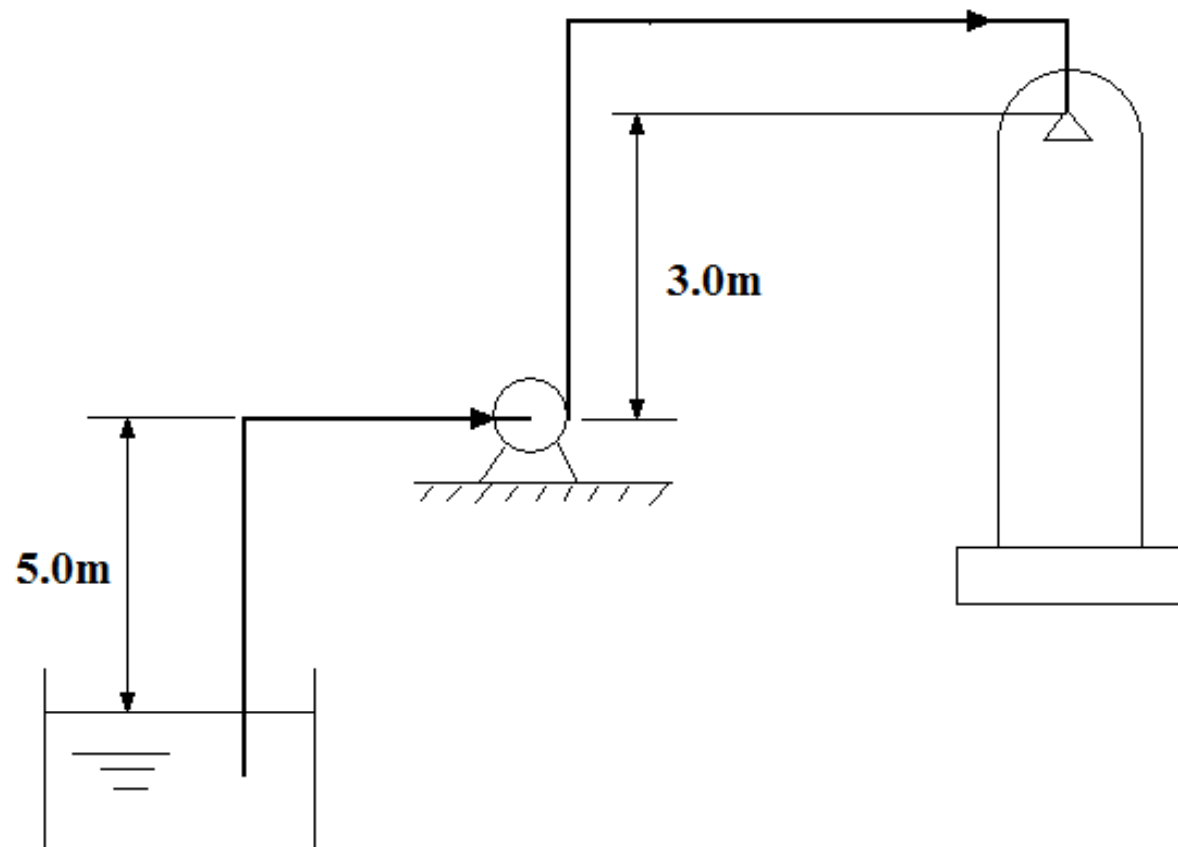
## 模拟实例

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**例1】** 某离心泵以 $40\text{m}^3/\text{h}$ 的流量将贮水池中 $5^\circ\text{C}$ 的热水用钢管输送到凉水塔顶，并经喷头喷入凉水塔中以达到冷却的目的。已知水在进入喷头前需要维持 $49\text{kPa}$ 的表压强，喷头入口较离心泵入口高 $3\text{m}$ ，离心泵较贮水池液面高 $5\text{m}$ 。泵的吸水管长度（包括所有局部阻力的当量长度，下同）为 $60\text{m}$ ，排出管长度为 $40\text{m}$ ，二者的内径均为 $100\text{mm}$ 。试计算该离心泵所需提供的压头。

# 模拟实例

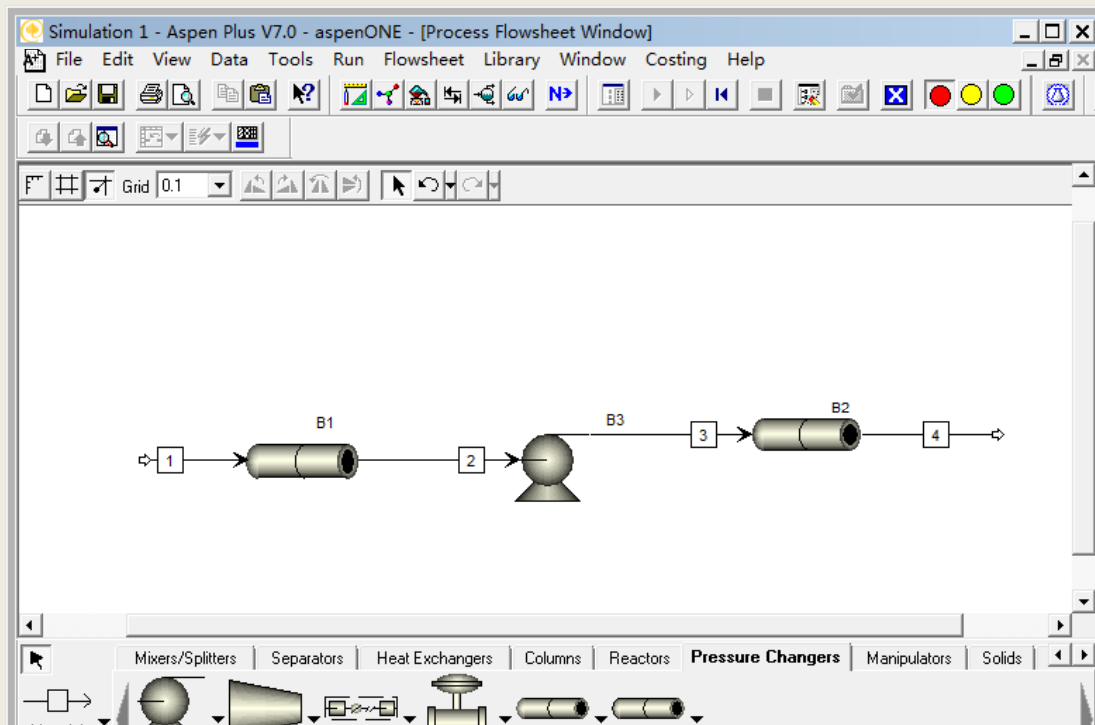
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# 模拟实例

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搭建流程图:

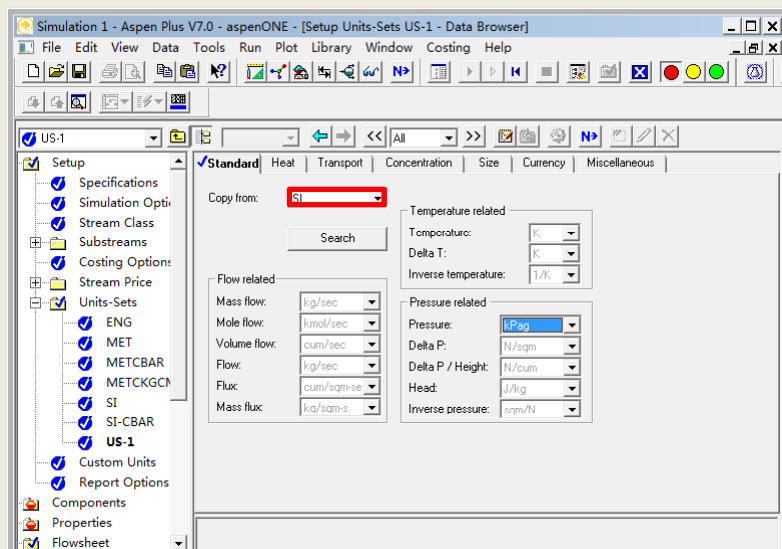




# 指定单位制

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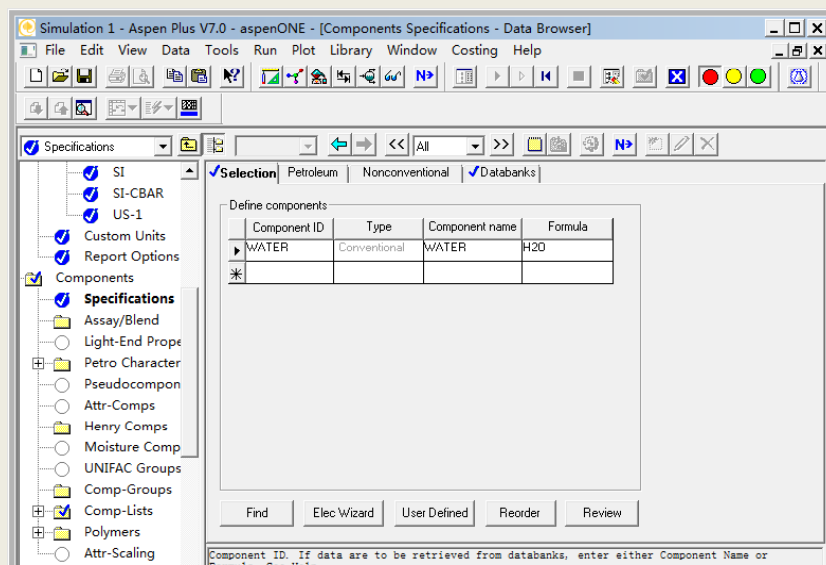
※ 指定国际单位制，压力单位设为kPag，如图：



# 指定组分

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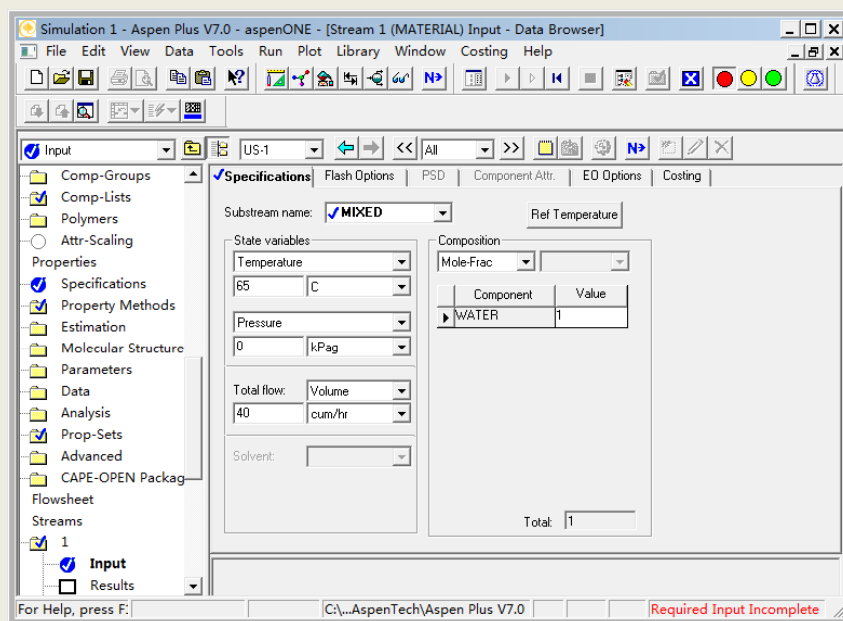
因离心泵输送的流体为水，所以只有一个组分，如图：



# 进料物流1的参数

43

输入进料物流1的参数，如图：



# 指定管路参数 (1)

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指定管路**B1**的参数，包括长度、内径、位置抬高及粗糙度，  
如图：

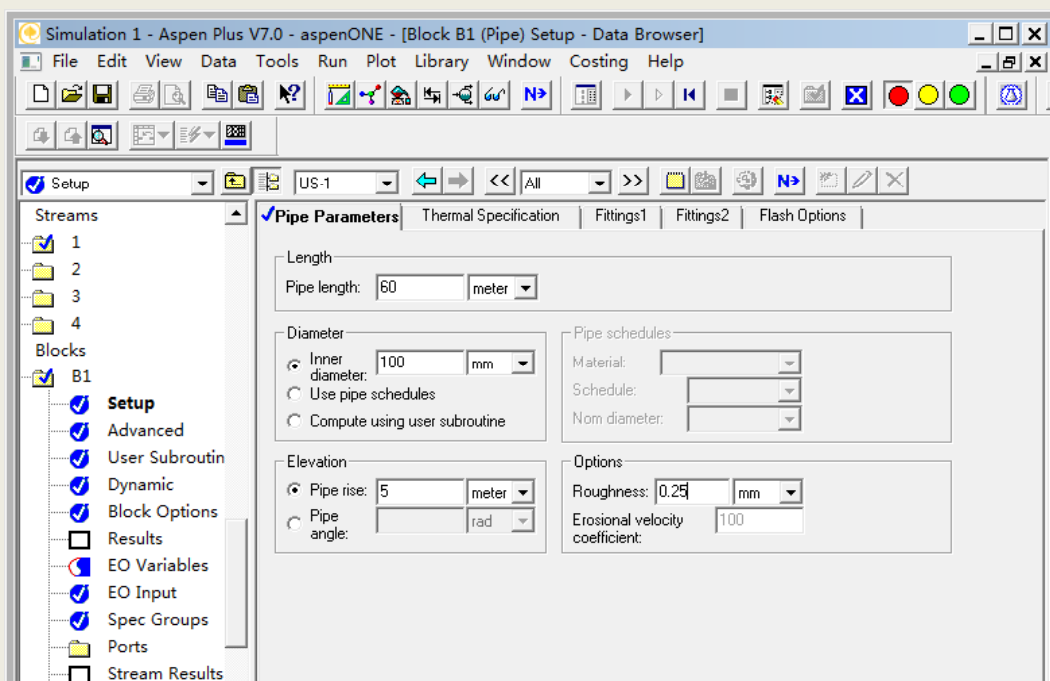


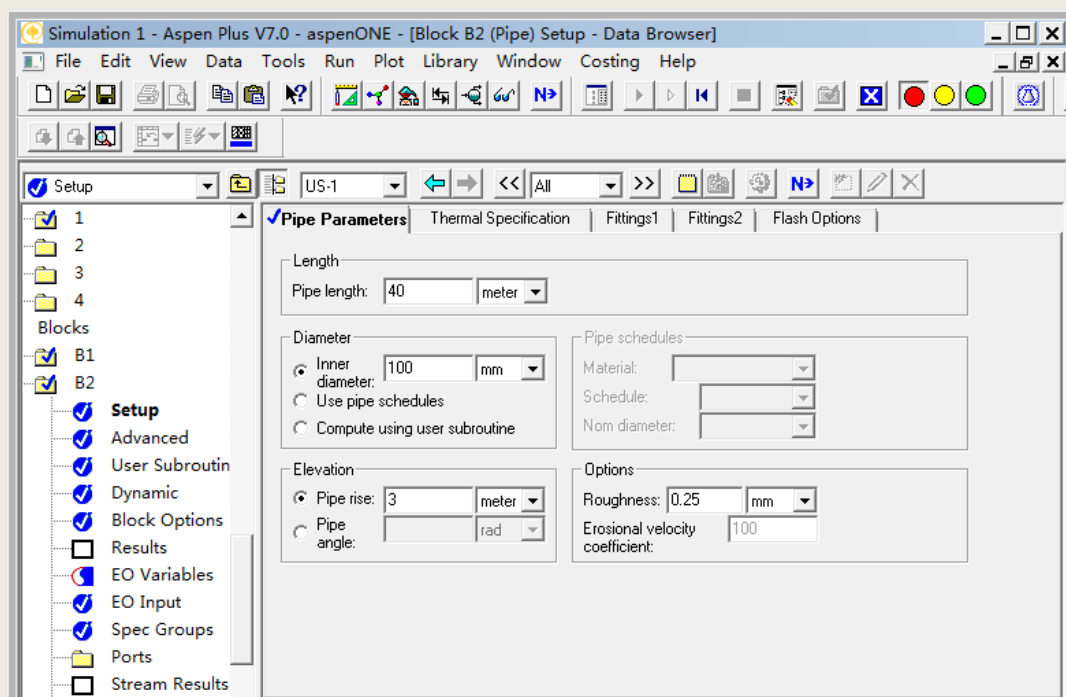
表2 某些工业管道的绝对粗糙度

金属管	绝对粗糙度(mm)	非金属管	绝对粗糙度(mm)
黄铜管、铜管及铝管	0.01-0.05	干净玻璃管	0.0015-0.01
无缝铜管或镀锌铁管	0.1-0.2	橡皮软管	0.01-0.03
新的铸铁管	0.25-1.0	木管道	0.25-1.25
新的无缝钢管	0.02-0.1	陶土排水管	0.45-6.0
轻度腐蚀的无缝钢管	0.2-0.3	表面抹得较好的混凝土管	0.3-0.8
显著腐蚀的无缝钢管	>0.5	表面平整的水泥管	0.3-0.8
旧的铸铁管	>0.85	新石棉水泥管	0.05-0.1
用多年的煤气总管	0.5	中等状况的石棉水泥管	0.03-0.8

## 指定管路参数 (2)

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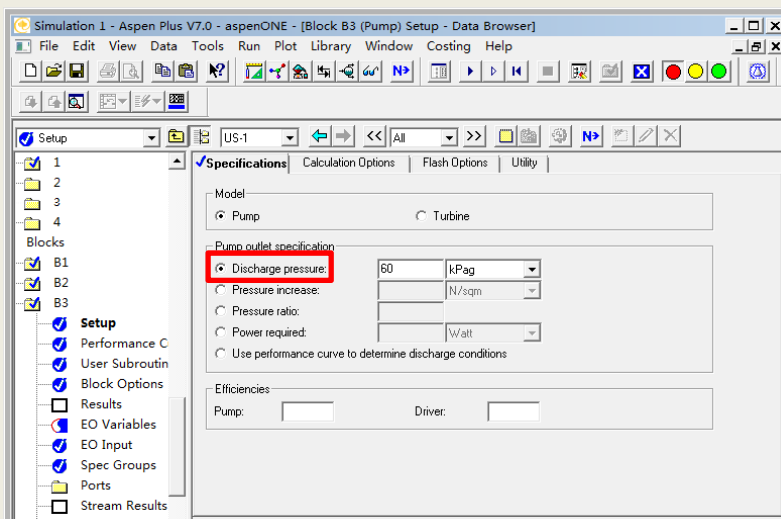
指定管路**B2**的参数，包括长度、内径、位置抬高及粗糙度，如图：



# 设置离心泵参数

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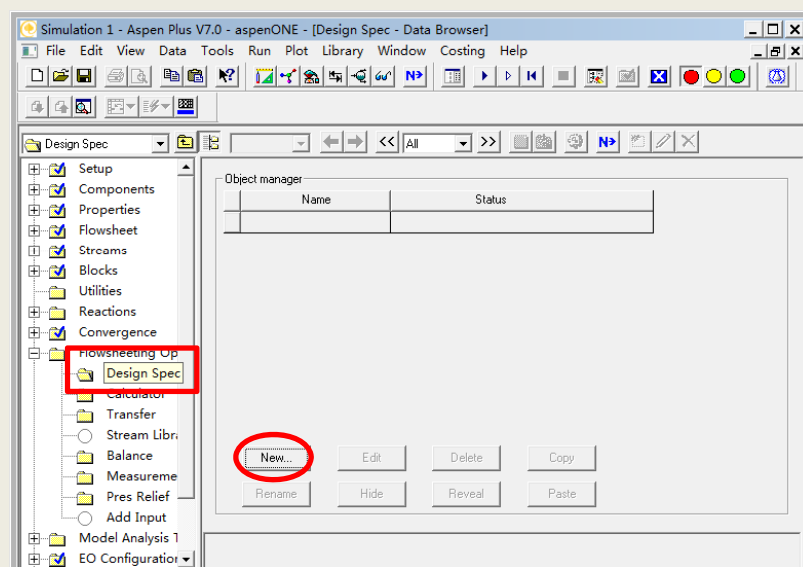
指定泵的类型为**Pump**，**排出压力**为**60 kPag**，实际上泵的出口压力应该在物流4的压力指定后即可确定，但**Aspen**为序贯模块法求解，所以需先输入一个初值，然后再添加一个设计规定来准确计算该值，如图：



# 添加设计规定 (1)

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在数据浏览器的**Flowsheeting Options/Design Spec**中新建一个设计规定，如图：

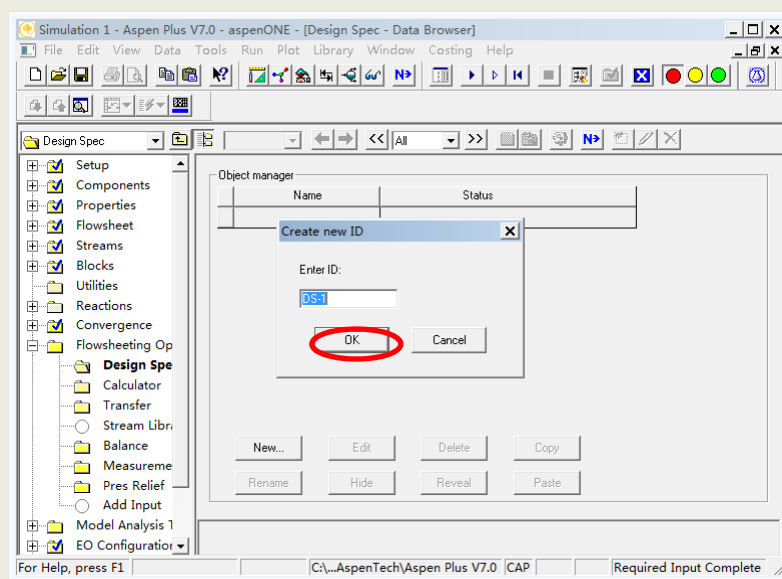




## 添加设计规定 (2)

49

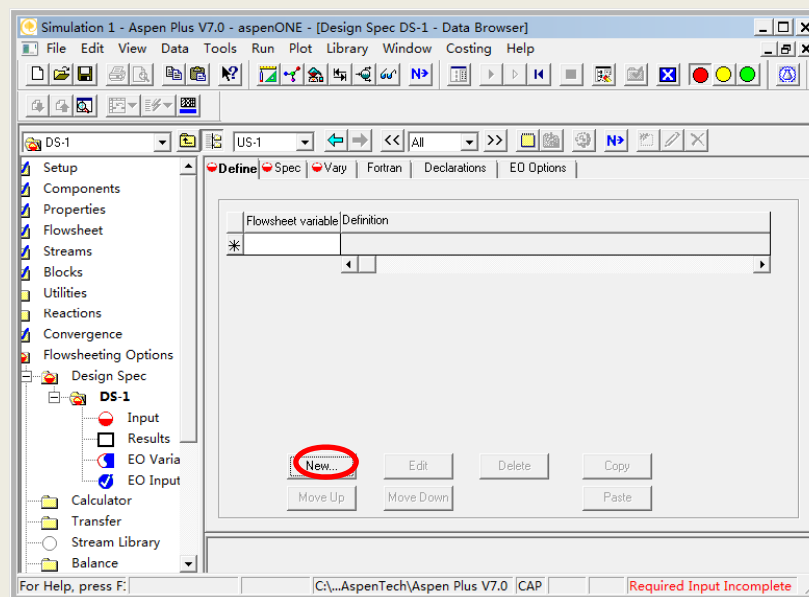
※ 点击上图的**New**，出现下图对话框，如图：



## 添加设计规定（3）

50

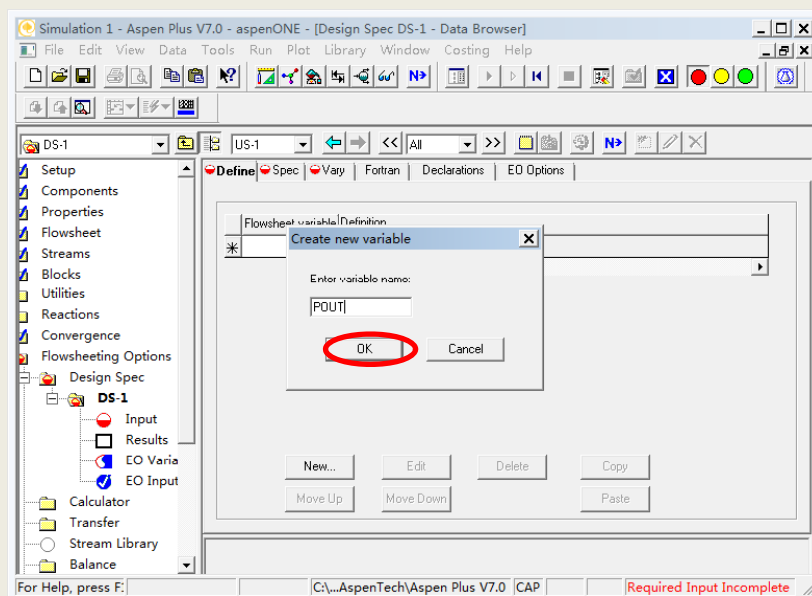
点击上图的**OK**，出现下图窗口，如图：



# 添加设计规定 (4)

51

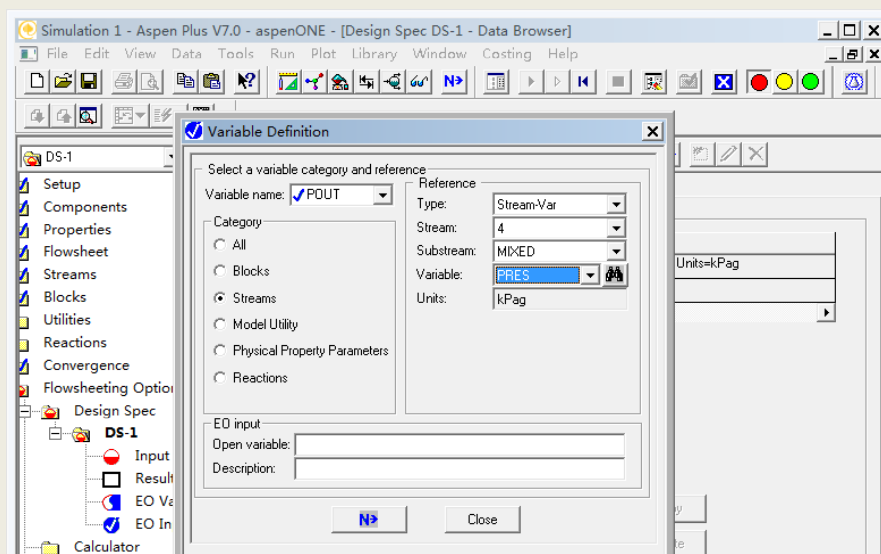
点击上图的**New**，出现下图对话框，并定义变量**POUT**，  
如图：



# 添加设计规定 (5)

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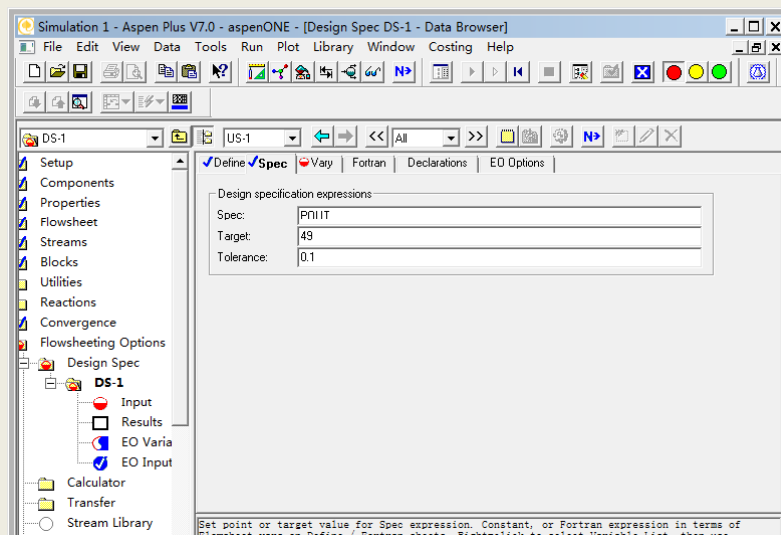
点击上图的**OK**，出现下图对话框并对变量进行如下定义，  
如图：



# 添加设计规定 (6)

53

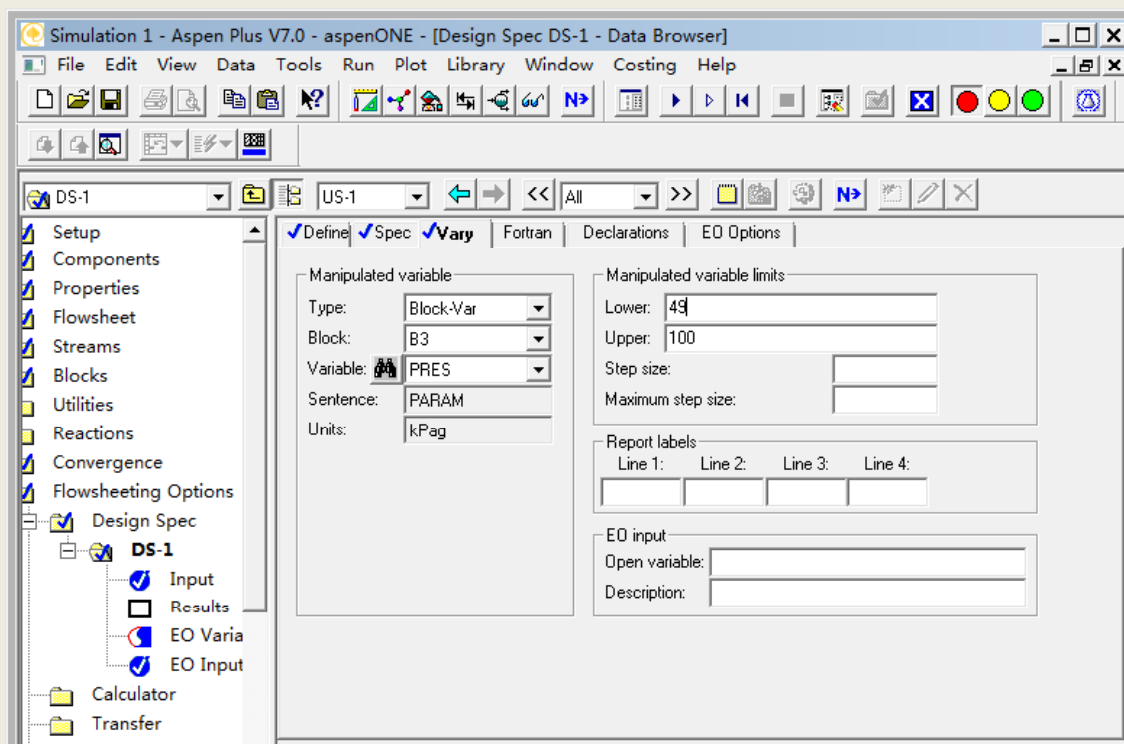
※ 调整离心泵的出口压力，使物流4的出口压力为49kPag，如图：



# 添加设计规定 (7)

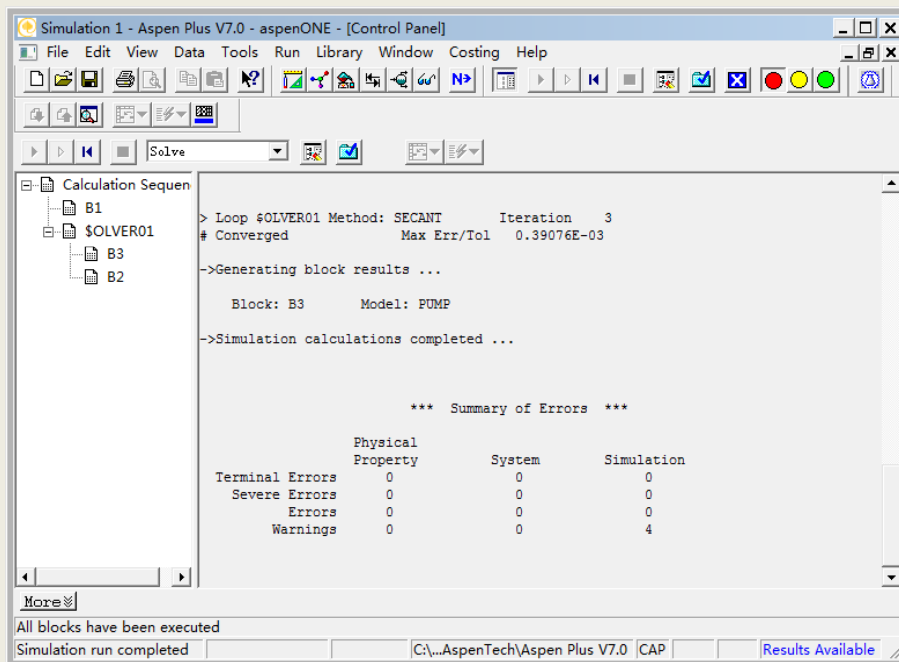
54

※调整离心泵的参数，如图：



# 运行模拟

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# 查看模拟结果 (1)

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可见离心泵的压头为**15.82m**，流量为**40m<sup>3</sup>/h**如图：

Simulation 1 - Aspen Plus V7.0 - aspenONE - [Block B3 (Pump) Results - Data Browser]

File Edit View Data Tools Run Plot Library Window Costing Help

Results

Components Properties Flowsheet Streams Blocks B1 B2 B3 Setup Perform User Su Block C Results EO Var EO Inpr Spec G Ports Stream Custom Utilities

Summary Balance Performance Curve Utility Usage

Pump results:

Fluid power:	1675.64745	Watt
Brake power:	2769.53599	Watt
Electricity:	2769.53599	Watt
Volumetric flow rate:	0.01111143	cum/sec
Pressure change:	150803.949	N/sqm
NPSH available:	17.4831071	J/kg
NPSH required:		
Head developed:	153.805187	J/kg
Pump efficiency used:	0.60502823	
Net work required:	2769.53599	Watt



## 模拟实例

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**例2】** 将**IS80-65-125**的离心泵放置在例1中给出管路中，试计算该离心泵的实际功率，并确定该的安装高度是否合适。

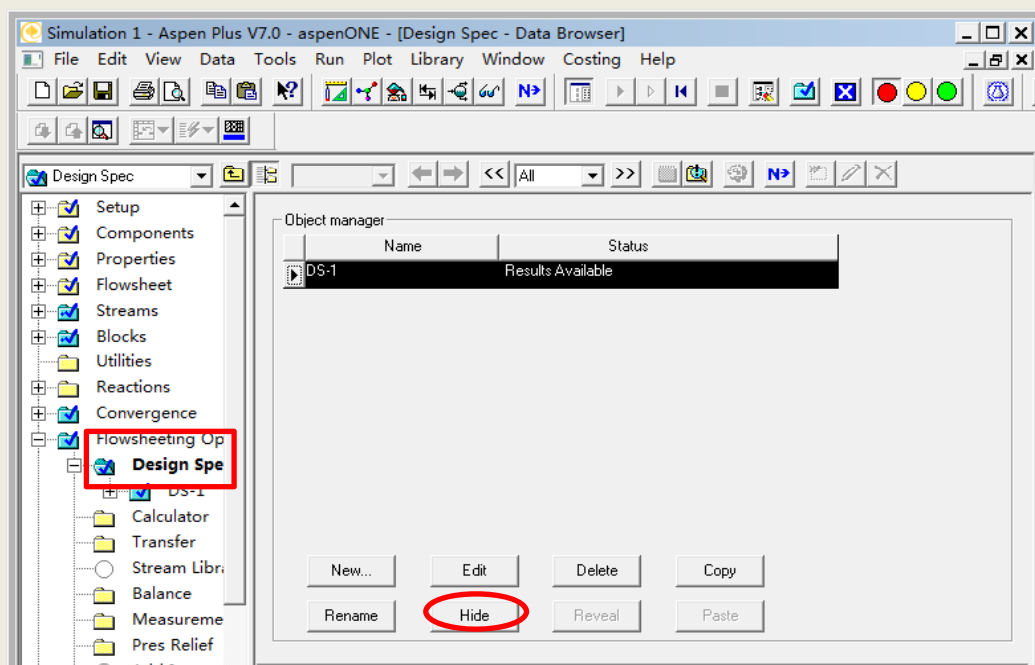
表1 IS80-65-125的特性曲线数据

Point	Flow	Head	Efficiency	NPSHR
1	30	22.5	0.64	3
2	50	20	0.75	3
3	60	18	0.74	3.5

# 隐藏设计规定 (1)

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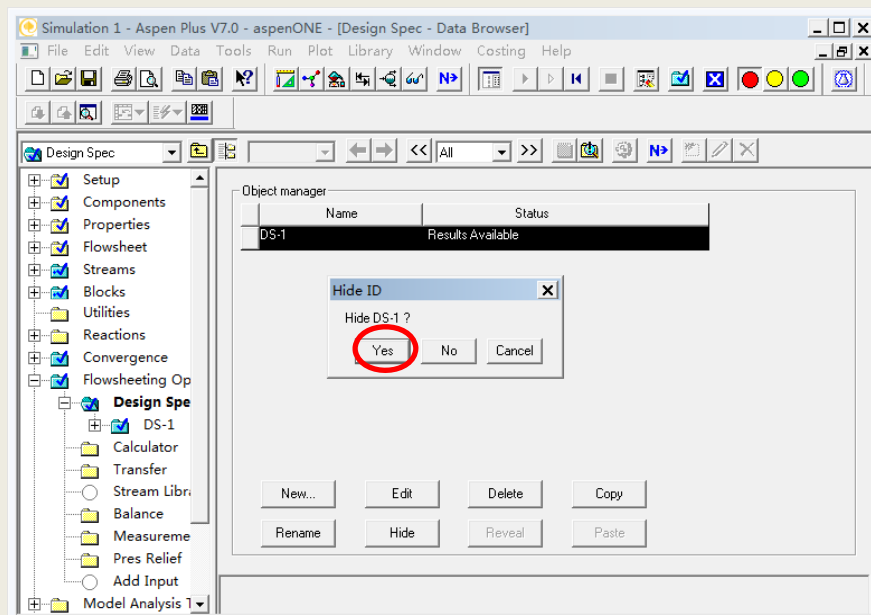
隐藏设计规定DS-1，如图：



## 隐藏设计规定（2）

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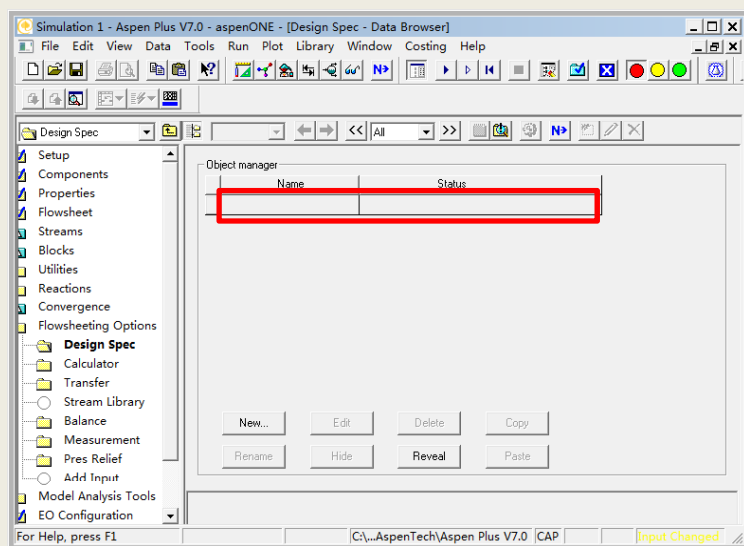
点击上图的**Hide**，出现下图对话框，如图：



# 隐藏设计规定 (3)

60

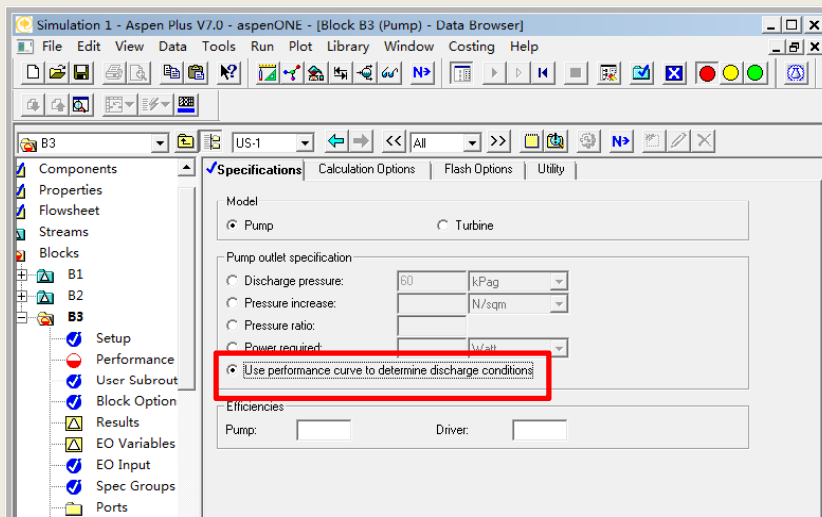
点击上图的**Yes**，设计规定**DS-1**已被隐藏，如图：



# 由泵的特性曲线计算泵的出口状态

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将**Pump outlet specification** 内容由**Discharge pressure**更改为**Use performance curve to determine discharge conditions**，表示将由泵的特性曲线来计算泵的出口状态，如图：

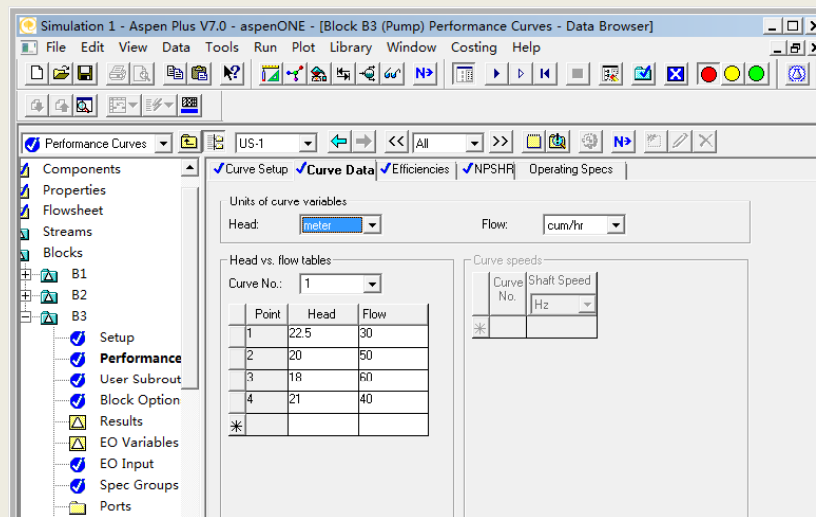




# 指定离心泵特性曲线参数（1）

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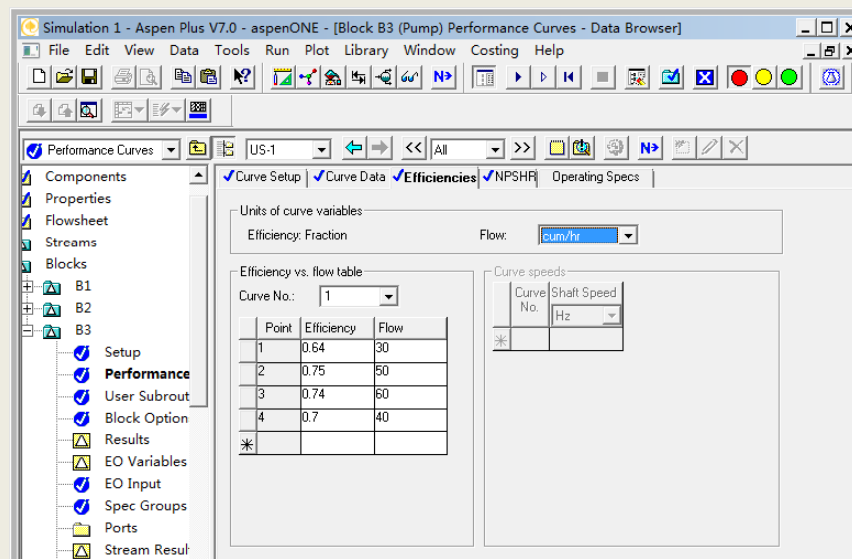
在**Curve Data**标签下输入压头流量数据，如图：



# 指定离心泵特性曲线参数（2）

64

在**Efficiencies**标签下输入效率流量数据，如图：

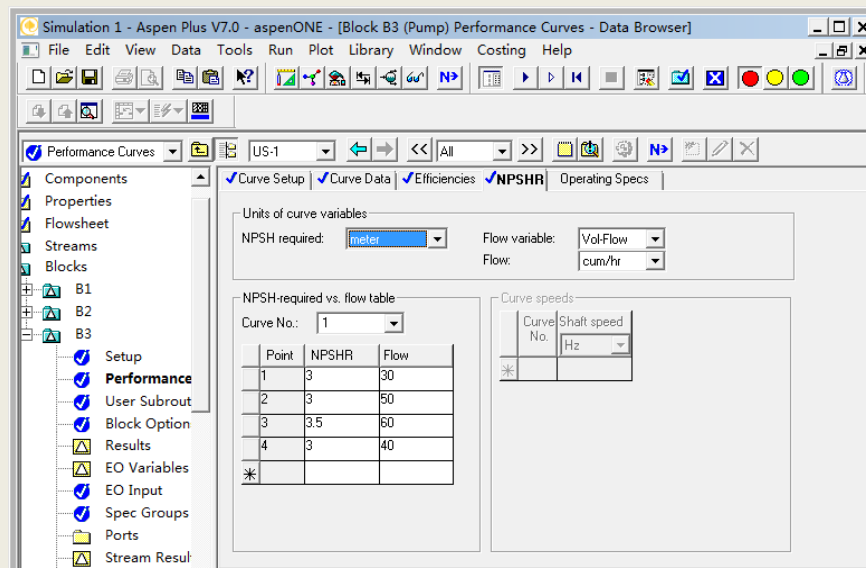




# 指定离心泵特性曲线参数（3）

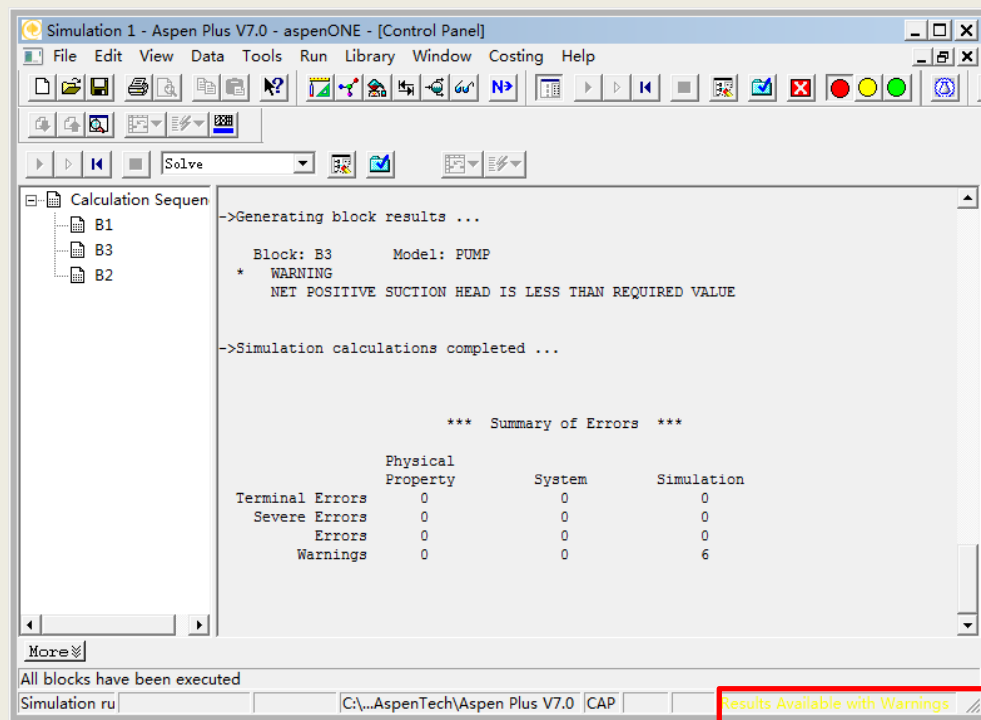
65

✘ 在**NPSHR**标签下输入必须汽蚀余量流量数据，如图：



# 运行模拟

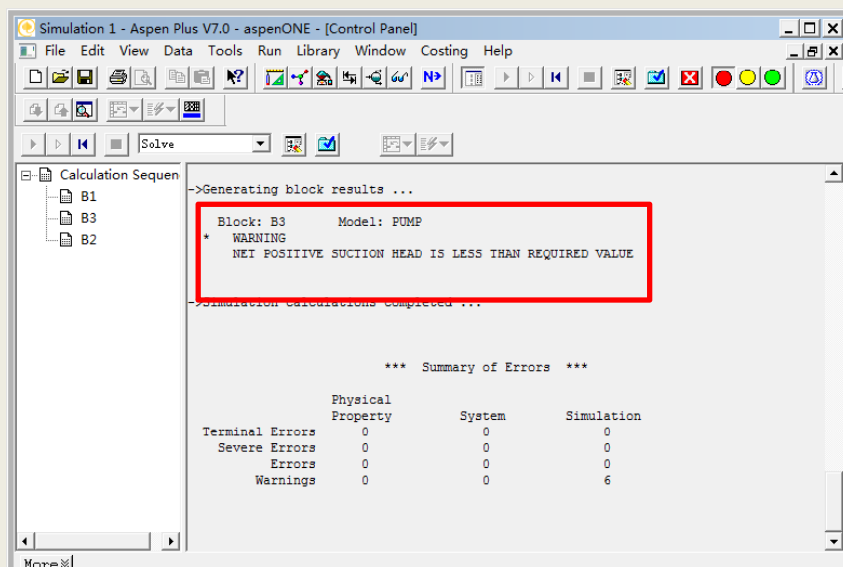
66



# 分析模拟结果

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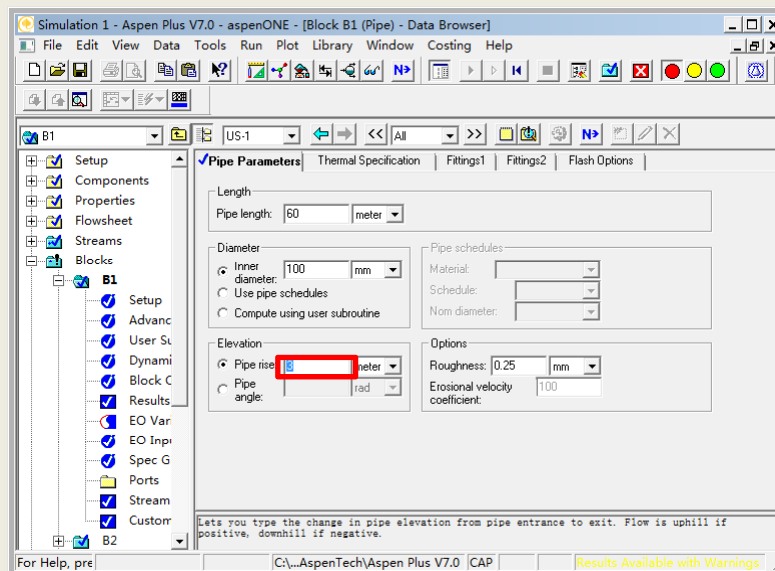
模拟运行之后有警告，查看迭代信息，发现警告信息含义为汽蚀余量小于必须汽蚀余量，如图：产生该信息的原因是泵的安装高度过大，必须降低安装高度。



# 降低安装高度（1）

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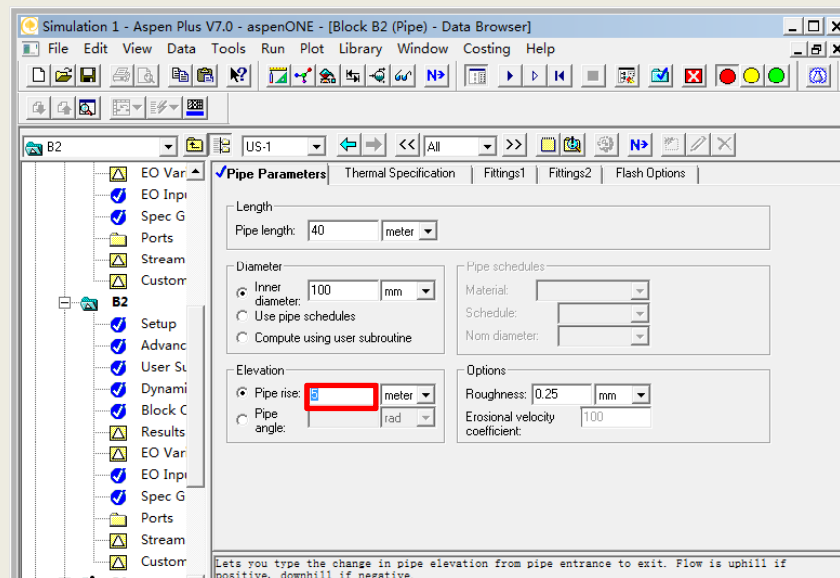
将B1的高度改为3m，即泵的安装高度由5m降低至3m，如图：



# 降低安装高度（2）

69

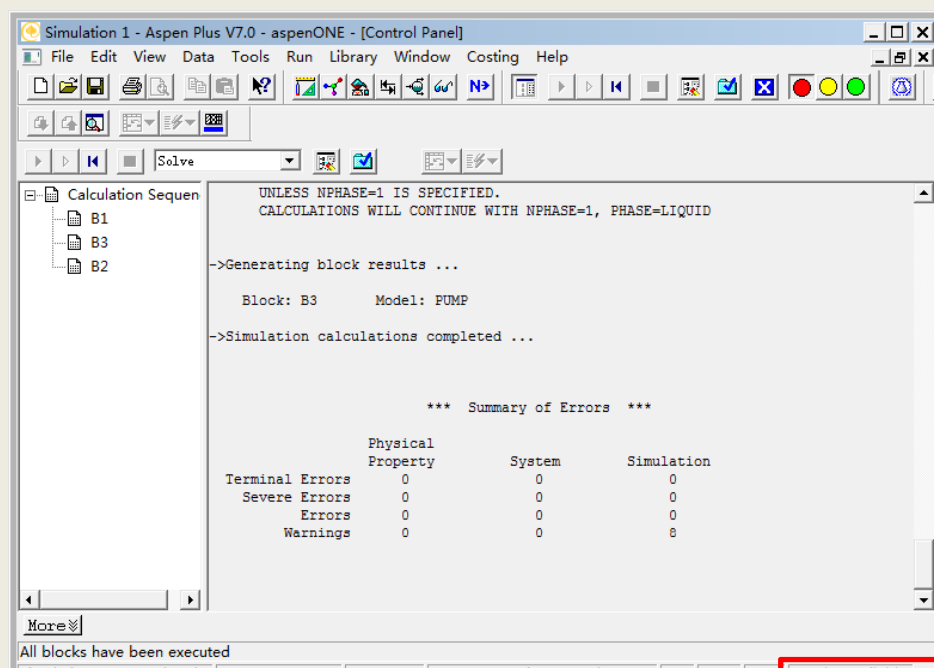
✘ 将B2的高度改为5m，如图：



# 重新计算

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说明3m的安装高度是合适的，如图：



# 查看泵的计算结果

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泵的计算结果已列入表中，如图：

Simulation 1 - Aspen Plus V7.0 - aspenONE - [Block B3 (Pump) Results - Data Browser]

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Results

Components Properties Flowsheet Streams Blocks

B1 B2 B3

Setup Perform User Su Block C Results EO Var EO Inpr Spec G Ports Stream

Summary Balance Performance Curve Utility Usage

Pump results:			
Fluid power:	2243.62193	Watt	有效功率
Brake power:	3205.15438	Watt	轴功率
Electricity:	3205.15438	Watt	电机功率
Volumetric flow rate:	40.0007966	cum/hr	体积流量
Pressure change:	201921.953	N/sqm	压力差
NPSH available:	37.0960373	J/kg	有效汽蚀余量
NPSH required:	29.4199505	J/kg	必须汽蚀余量
Head developed:	20.9999047	meter	压头
Pump efficiency used:	0.70000433		泵效率
Net work required:	3205.15438	Watt	总功率

## 模拟实例

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**【例3】** 流量为  $5000 \text{ kg/h}$ ，压强为  $7 \text{ bar}$  的饱和水蒸汽流经  $\phi 108 \times 4 \text{ mm}$  的管道。管道长  $20 \text{ m}$ ，出口比进口高  $5 \text{ m}$ ，粗糙度为  $0.05 \text{ mm}$ 。管道采用法兰连接，装有闸阀 1 个， $90^\circ$  肘管 2 个。环境温度  $20^\circ \text{C}$ ，传热系数为  $20 \text{ W}/(\text{m}^2 \cdot \text{K})$ 。求：出口处蒸汽的压强、温度和含水率，以及管道的热损失各为多少？

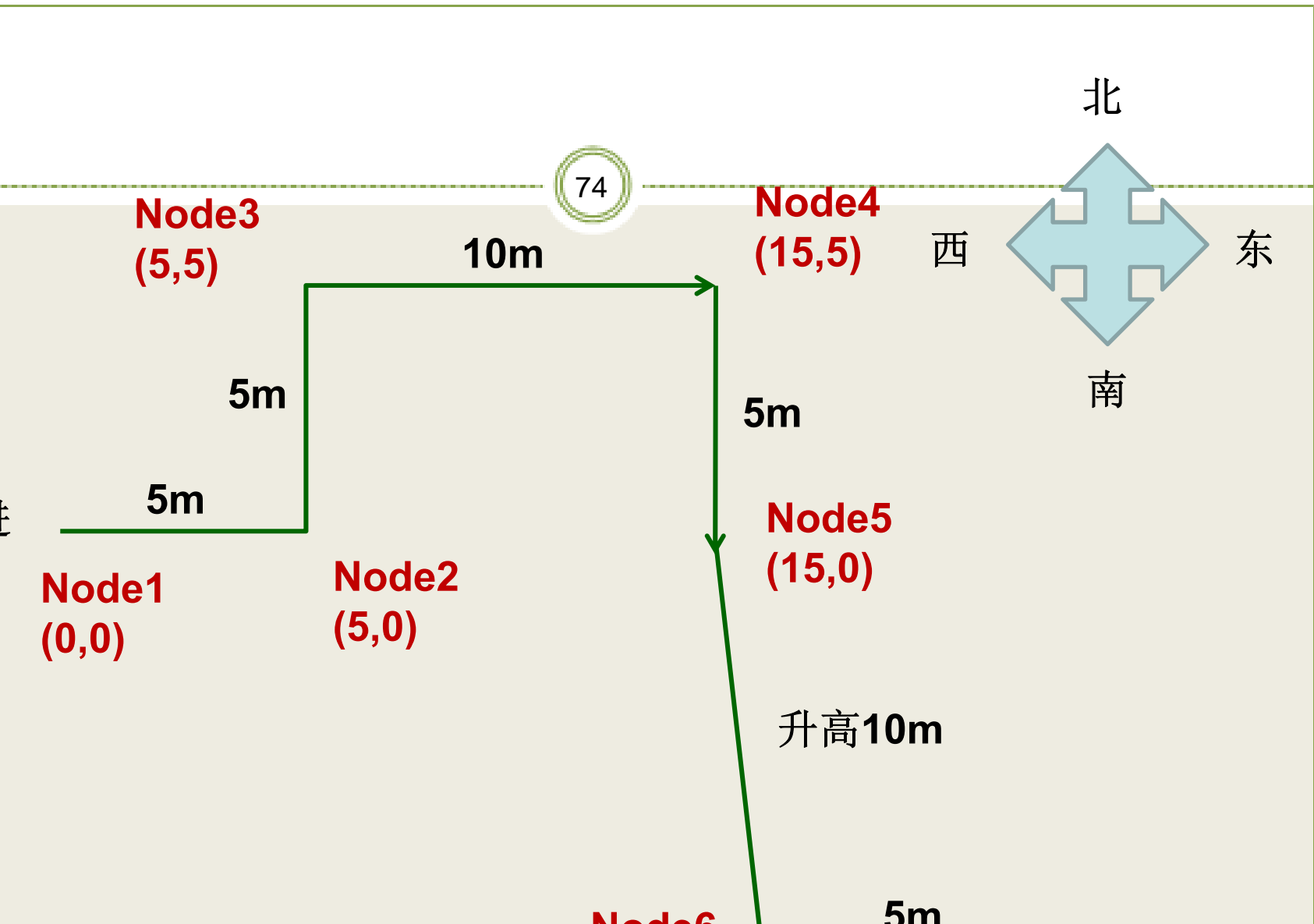


## 模拟实例

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**【例4】** 流量为  $100 \text{ m}^3/\text{h}$ ，温度为  $50 \text{ }^\circ\text{C}$ ，压力为  $5 \text{ bar}$  的水流经  $\phi 108 \times 4$  的管线。管线首先向东延伸  $5 \text{ m}$ ，再向北  $5 \text{ m}$ ，再向东  $10 \text{ m}$ ，再向南  $5 \text{ m}$ ，然后升高  $10 \text{ m}$ ，再向东  $5 \text{ m}$ 。管内壁粗糙度为  $0.05 \text{ mm}$ 。

问：管线出口外的压降是多少？



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# 结束

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下节内容：Aspen中的换热器模块