



SJT

Steam Jet Thermocompressor

Description

In this environmentally conscious world, companies within the Process Industries Sector are becoming more aware of the additional cost savings that can be made at the same time as committing to a friendly environment.

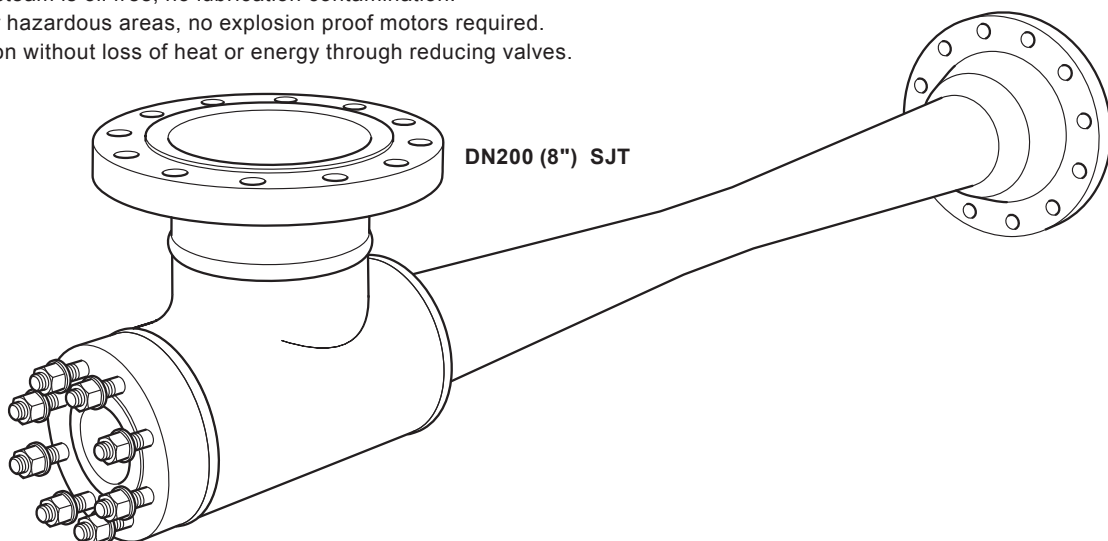
One such common area is the steam raising plant and the proportion of waste product that is put to atmosphere. If the amount of waste can be reduced and thereby have an effect on the amount that is being generated in the first place, then the environment will be improved and the running costs reduced. It is in this area of operation that the application of an SJT Steam Jet Thermocompressor can be advantageous.

Spirax Sarco has been designing innovative solutions for steam plant engineering and cost effective manufacturing for over 25 years. The Steam Jet Thermocompressor is a prime example of this commitment; the SJT is an energy saving device that compresses low pressure steam, often waste steam, to a higher useable pressure. All of Spirax Sarco's SJT Steam Jet Thermocompressors are designed and built to the customers specific criteria, for their intended application, to provide optimum performance and return on investment.

An SJT Steam Jet Thermocompressor can be described as a type of Ejector. It uses a jet of high pressure steam (called the Motive pressure) to entrain low pressure water vapour (called the Suction pressure). The two mediums are intimately mixed and subsequently discharged at a pressure that lies somewhere between the motive and suction pressures.

Advantages over electromechanical alternatives:

- Simple construction; SJT Steam Jet Thermocompressors can be made from any machineable materials for increased abrasion resistance.
- Compact design and comparatively lightweight which enables overhead installations.
- Low capital cost and operating costs.
- No moving or rotating parts with minimal maintenance and therefore the units can be installed in remote or inaccessible locations.
- No specialist maintenance experience required.
- Discharge steam is oil free, no lubrication contamination.
- Suitable for hazardous areas, no explosion proof motors required.
- Recirculation without loss of heat or energy through reducing valves.



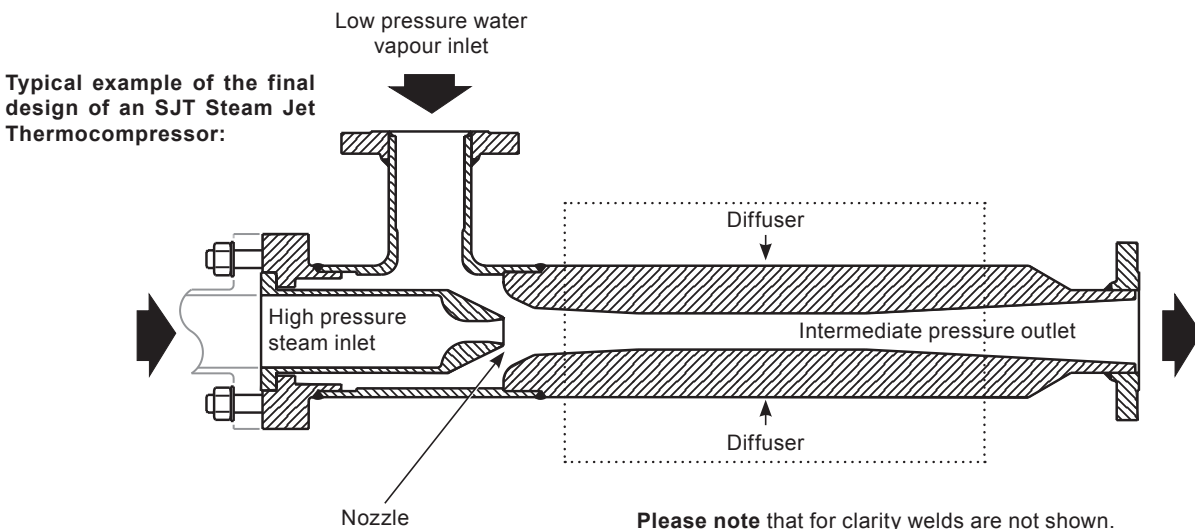
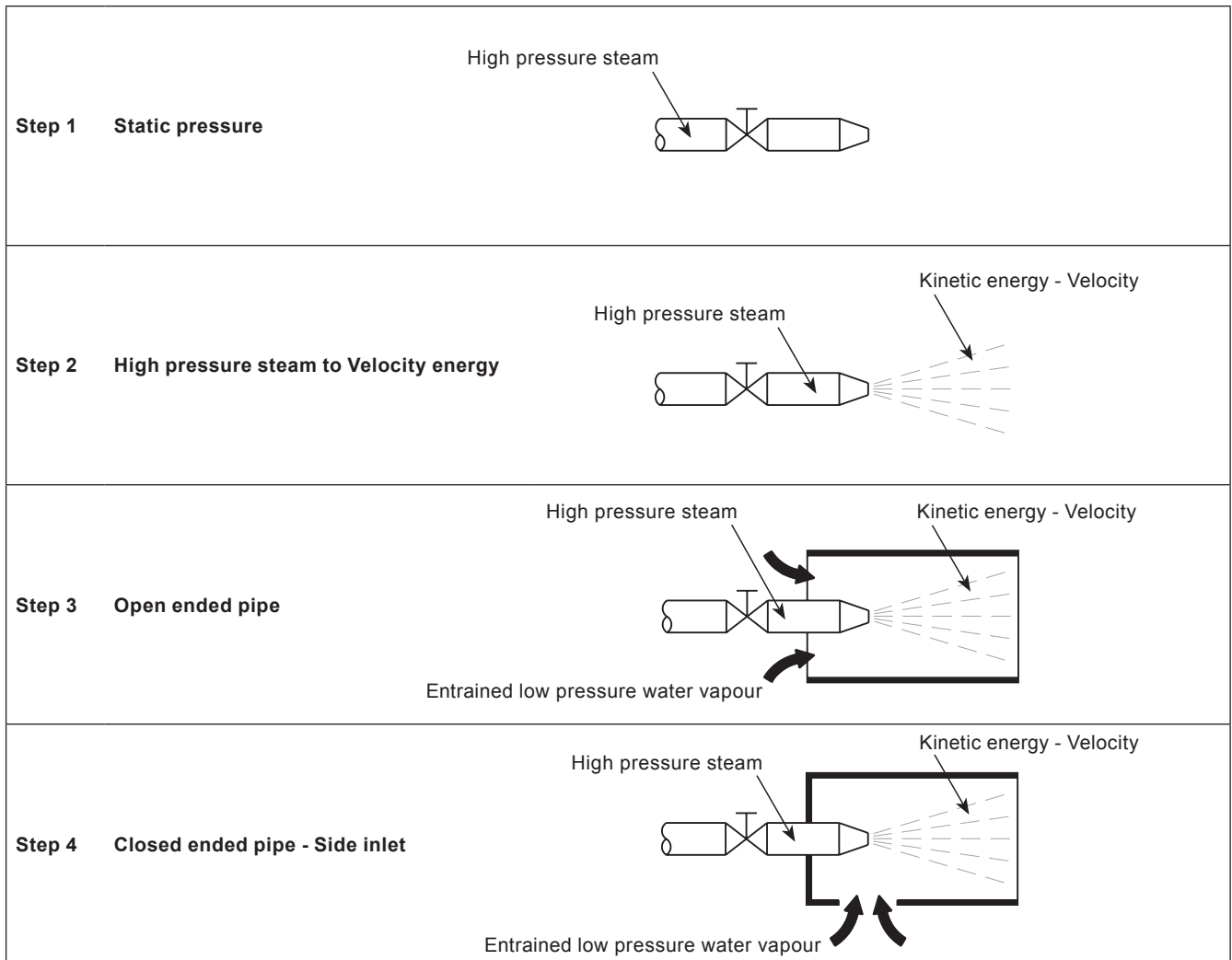
Typical applications

The following lists the applications where SJT Steam Jet Thermocompressors can be installed, typically for circulating and boosting low pressure steam which would normally go to waste.

Drum dryers	Paper and Board Industries
Flash evaporators	Desalination
Condensate receivers	Chemical, Petro-chemical, Oil and Power Generation
Vulcanisers	Rubber Industry
Single and Multi-stage effect evaporators	Food, Dairy, Pharmaceutical & Chemical Industries
Wort vessels	Brewing Industry
Exhaust steam lines	Most Process Industries
Blanching machines	Food Industry

How the SJT Steam Jet Thermocompressor (Ejector) works

The **four steps** below illustrates in a simple way how an 'Ejector' is created:

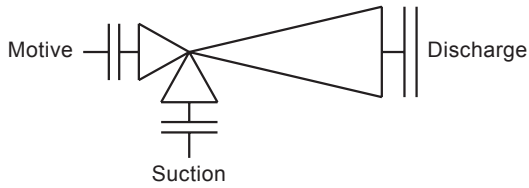


High pressure motive steam enters the SJT Steam Jet Thermocompressor and passes through the nozzle where the high pressure steam energy is converted into kinetic energy. On leaving the nozzle at high velocity, the steam enters the suction chamber where it is brought in contact with the suction stream. There is then an exchange of momentum between the motive and suction streams, resulting in an acceleration of the suction vapours, giving rise to their subsequent entrainment. A uniform mixture results at the narrowest part of the diffuser (called the throat) and finally the reconversion of the velocity energy into pressure energy occurs in the diverging section of the diffuser.

An SJT Steam Jet Thermocompressor is a type of Ejector that uses high pressure (HP) steam to entrain low pressure water vapour (LP) and discharges at a pressure (P_a) that lies somewhere between the HP and LP pressures.

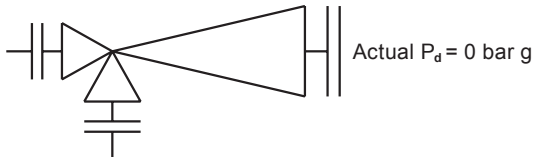
Understanding SJT Steam Jet Thermocompressor discharge pressures

An SJT Steam Jet Thermocompressor can be represented by the adjacent diagram:



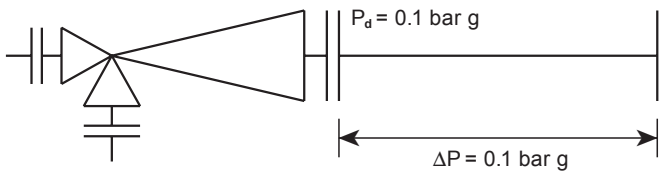
The SJT Steam Jet Thermocompressor is designed to 'match' a specific discharge pressure. For example the following SJT is designed to discharge against a backpressure of 18.5 bar g.

However, if the unit is allowed to discharge to atmosphere, the actual discharge pressure is atmospheric pressure, even though it was designed to discharge at a higher pressure.

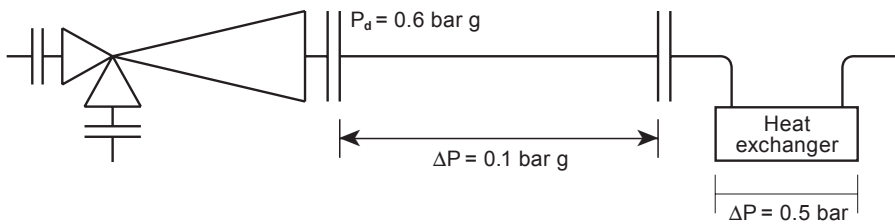


Where: P_d = Discharge pressure

If a small section of pipework is placed after the SJT which has a pressure drop of 0.1 bar, the pressure immediately downstream of the SJT is 0.1 bar g. The pressure after the pipework is atmospheric.



If we add a process after this pipework, for example a heat exchanger, with a pressure drop of 0.5 bar, the pressure at the discharge branch of the SJT is 0.6 bar g.



Now, if we take a process (or a steam header) that operates at a pressure of 16 bar g, and the pressure drop through the pipework between the process and the SJT is 2.5 bar, the pressure at the discharge of the SJT is 18.5 bar g.



For the purpose of this example the SJT is operating at its design discharge pressure as the unit was designed for a discharge pressure of 18.5 bar g.

Please note that the SJT Steam Jet Thermocompressor does not 'create' the discharge pressure. It is designed to match a discharge pressure.

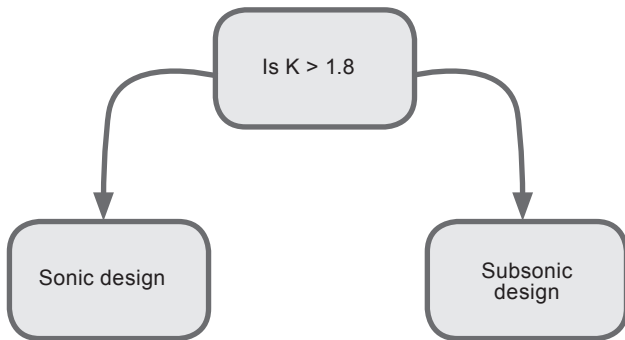
Types of thermocompressor

There are two types of thermocompressor; Sonic and Subsonic. Although they look similar, they behave differently and must be controlled differently.

Compression ratio

In order to determine what type of design the Thermocompressor will be, we need to calculate the 'Compression ratio'.

$$\text{Compression ratio (K)} = \frac{\text{Discharge pressure (P}_d\text{)}}{\text{Suction pressure (P}_s\text{)}}$$



For Example:

- The discharge pressure = 2.5 bar g = 3.513 bar a
- The suction pressure = 1.2 bar g = 2.213 bar a
- The Compression ratio (K) = $\frac{3.513}{2.213} = 1.59$

Sonic designs:

- Compression ratio (K) greater than 1.8
- With a sonic design, the Motive (HP) steam flowrate is 'fixed'
- The Suction (LP) steam flowrate can operate with full turndown (100% to 0%)

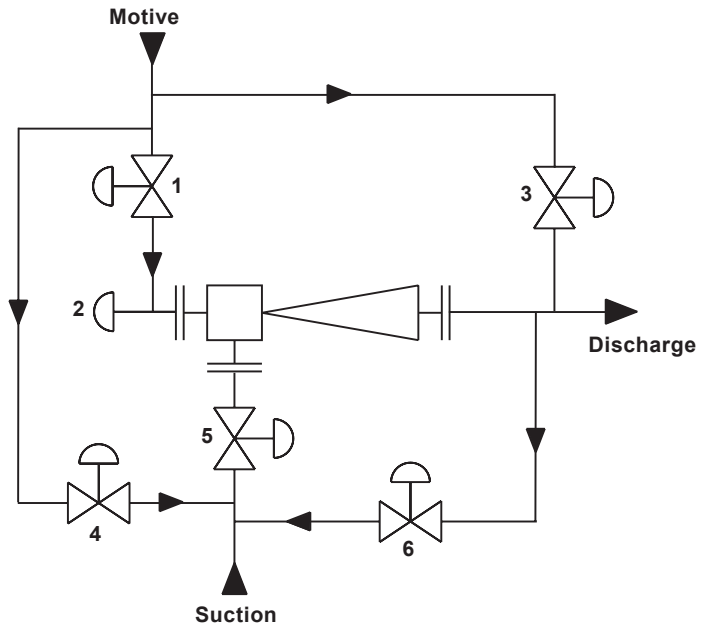
Subsonic designs:

- Compression ratio (K) is less than 1.8
- With a subsonic design, the Motive (HP) steam flowrate can be varied to 'save' steam when process conditions become more favourable
- The Suction (LP) steam flowrate can operate with full turndown (100% to 0%)
- Spirax Sarco offer a special design called a 'Variable Orifice' thermocompressor which has integrated Motive steam control.

Therefore the subsonic design will provide the optimum performance and effectiveness for the given application.

Control options

The schematic below illustrates every possible control option that could be used to control an SJT Steam Jet Thermocompressor.



Sonic designs:

Option 6	is usually used to maintain the Suction (LP) pressure (if required)
Options 4 or 5	are occasionally used instead
Option 3	can be used to bypass additional steam to the discharge
Please note that you cannot choose Options 1 or 2 if the SJT Steam Jet Thermocompressor is 'Sonic'	

Subsonic design

Option 2	can be used to control the Motive (HP) steam flow from 100% to 35%
Option 1	can be used to control the Motive (HP) steam flow from 100% to 80%
Option 3	can be used to bypass additional steam to the discharge. Options 4 or 5 or 6 are occasionally used to maintain the Suction (LP) pressure.

Most applications will only use one of the options. Some applications do not require any control. An SJT Steam Jet Thermocompressor will always balance itself to the system pressures.

You should decide what parameter (pressure, flow etc.) you wish to control as this will determine what option is best for the given application. Spirax Sarco can provide assistance in selecting the best control option for the intended application to provide optimum performance and return on investment.

Variable orifice SJT Steam Jet Thermocompressors

Spirax Sarco offers several types of Thermocompressor. The first is the fixed nozzle type which cannot be controlled to any great extent, although some control is achievable by throttling the motive steam pressure via a separate valve upstream of the SJT Steam Jet Thermocompressor (See Control Option 1, page 5, for subsonic units).

The other type relies on a motive steam regulating spindle to vary the cross sectional area of the motive steam nozzle (Control Option 2, page 5.). Unlike a throttling valve positioned upstream, the regulating spindle does not reduce the motive steam pressure, it simply varies the area through which the steam is flowing. This approach maximises the energy per kg of motive steam that is available at the nozzle to do the work. With an installation involving an upstream throttling valve, useful energy is lost in the throttling process.

SJT Steam Jet Thermocompressors utilizing a motive steam regulating spindle are often referred to as Variable Orifice Ejectors. The spindle is operated automatically. These should be specified in cases where the suction load, suction pressure or discharge pressure are continually varying, and it is necessary to control one or more of these process parameters as quickly as possible.

Note:

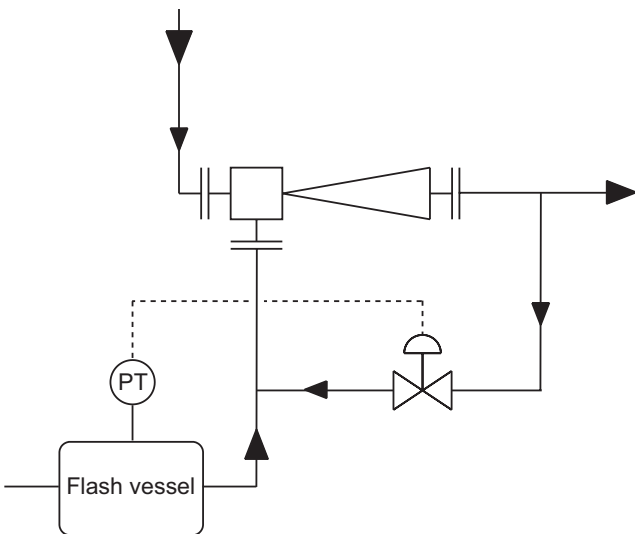
For cases which involve large variations in load, it is sometimes more cost effective to use several various sized units connected in parallel, than to have one large controlled unit. It may also be necessary to install a bypass valve in some applications.

Online calculation software

Example

A client wishes to recover 1500 kg/h steam from a flash vessel which operates at 0.1 bar g and wants to compress it to 1.5 bar g to be used in a process. HP steam is available at 20 bar g, dry and saturated.

The water flow to the flash vessel can vary. The pressure in the flash vessel must not fall below 0.5 bar a.



Method

We can use the Spirax Sarco Online Sizing Software to design a suitable unit (available at www.spiraxsarco.com with password).

When the calculation button is pressed, the software will calculate the required Motive (HP) steam flowrate and the unit connection sizes. The user will see a summary screen, at which point the desired flange rating can be selected and then the 'Save & Email' button can be pressed - A Datasheet and GA Drawing, page 7, will then be sent to your chosen email address.

The software will automatically determine if the unit is Sonic or Subsonic and designed accordingly.

SJT Steam Jet Thermocompressor Quote

Welcome to the online quote system. Please complete the details below:

Client Reference			
Input			
Pressure bar(g)	Motive 20	Suction 0.1	Discharge 1.5
Temperature °C	<input checked="" type="radio"/> Tsat <input type="radio"/> Other:	<input checked="" type="radio"/> Tsat <input type="radio"/> Other:	
Flowrate kg/h		1500	
Mechanical Design Conditions			
Pressure bar(g)	Motive 25	Suction/Discharge 25	
Temperature °C	220		
<input type="button" value="Calculate >"/> (it may take a few minutes to calculate)			

Datasheet generated by the online software program

A typical example is illustrated below:

Spirax Sarco SJT Steam Jet Thermocompressor Datasheet						
1	Client:	Spirax-Sarco Limited	Client Project Ref:			
2	Client's Ref:		Plant Location:			
3	Spirax Ref:	SJT Example/SJT00824	Name-plate Tag No.			
4	Description:	Size 6 Steam Jet Thermocompressor	No. OFF:	1		
5	Unit Ref:	SJT150CS4F0	Operation:			
6	Drawing No:	DE-SJT00824-1	Serial No:			
7	Unit Body Size:	6				
8	MOTIVE CONDITIONS		MATERIALS OF CONSTRUCTION			
9	Pressure	(bar g) 20.00	Main body	Carbon Steel		
10	Temperature	(C) 215.0	Nozzle	Stainless Steel		
11	Flowrate	(kg/hr) 2580	Diffuser	Carbon Steel		
12			Flanges	Carbon Steel		
13	SUCTION CONDITIONS		Gaskets	Spirax Sarco to select		
14	Pressure	(bar g) 0.10	Bolts	Carbon Steel (if applicable)		
15	Temperature	(C) 102.7	Name-plate	Stainless Steel		
16	Flowrate	(kg/hr) 1500				
17			MECHANICAL DESIGN	Motive	Suction/Discharge	
18	DISCHARGE CONDITIONS			Side	Side	
19	Pressure	(bar g) 1.50	Max Design Pressure	25	25	(bar g)
20	Temperature	(C) 145.6	Max Design Temp	220	220	(C)
21	Flowrate	(kg/hr) 4080	Internal Corrosion Allowance	1.5	1.5	(mm)
22	DIFFUSER IS SONIC		Mechanical Design Code	ASME B31.3		
23			Welding Standard	ASME IX		
24			External Surface Finish	High Temp Silicone Aluminum		
25			Weight	TBC (kg)		
26						
27	DIMENSIONS		CONNECTIONS DETAILS		Size	Rating
28	A - 245 mm		Motive Steam (A)	2 ½	300 LB	
29	B - 290 mm		Suction Steam (B)	6	300 LB	
30	C - 1375 mm		Discharge Steam (C)	6	300 LB	
31	D - 1665 mm		Flange Type	ASME B 16.5 Slip-On		
32	GA DRAWING					
33	<p>The drawing is a cross-sectional view of the steam jet thermocompressor. It shows a central nozzle assembly with a gasket. The nozzle is connected to a body, which has a name-plate. The body is connected to a diffuser. Dimensions A, B, C, and D are indicated with arrows. A is the height of the nozzle assembly. B is the distance from the nozzle to the start of the diffuser. C is the length of the diffuser. D is the total length of the unit.</p>					
34						
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43	NOTE: Confirmed dimensions to be issued shortly after order placement					

Selection example:

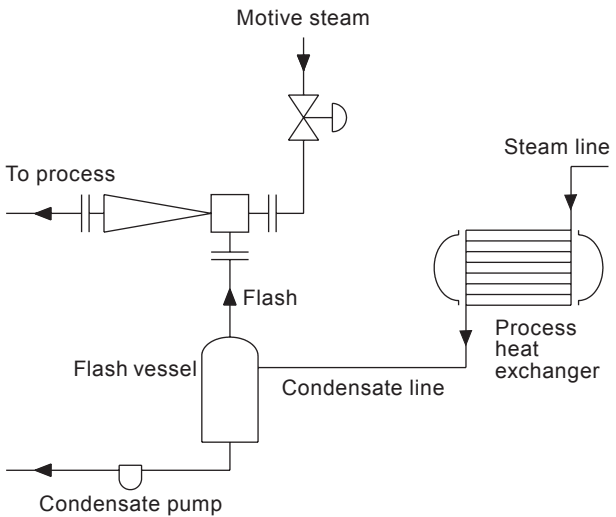
A Spirax Sarco Size 6 Steam Jet Thermocompressor has been selected. The required Motive (HP) steam flowrate is 2580 kg/h. Approximate dimensions are shown and the Motive, Suction and Discharge connection sizes have been calculated.

Control

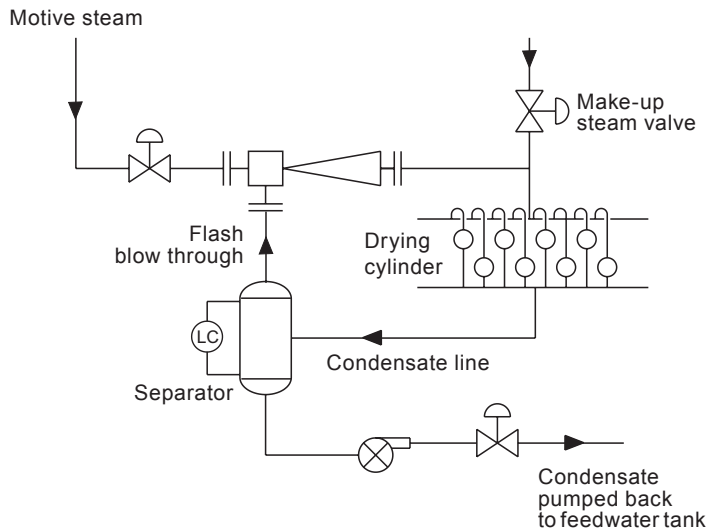
The compression ratio is 2.25 (see the example on page 4 that illustrates how to calculate the compression ratio) so the SJT Steam Jet Thermocompressor will be 'Sonic'. Therefore the calculated Motive (HP) steam flowrate must be fixed.

The SJT Steam Jet Thermocompressor is designed for a Suction flowrate of 1500 kg/h. Without control, if the Suction (LP) steam flowrate falls, the SJT will try and suck harder and the Suction pressure will begin to fall. Consequently, in this application, we can install a simple 'recycle' loop. This recycles some discharge steam back to the suction. By maintaining the Suction flow, the SJT operates at its design point which keeps the Suction pressure constant.

Typical application drawings:



Typical SJT Steam Jet Thermocompressor application



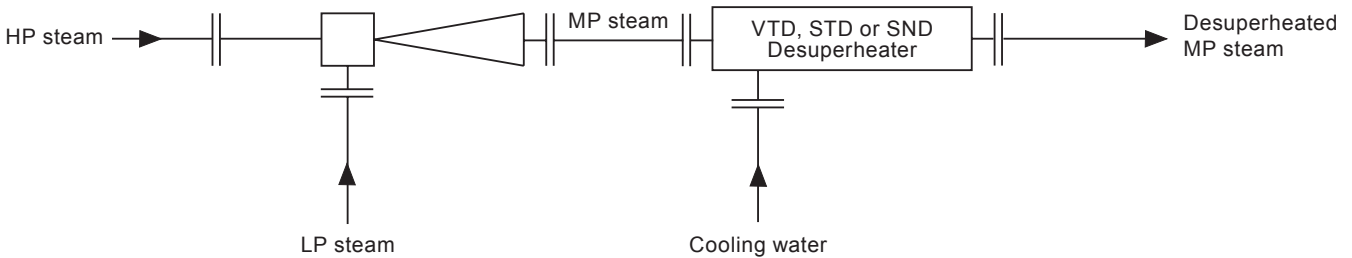
Typical Paper Mill application

Additional application opportunity

Thermodynamically, the process of recompressing low pressure steam using high pressure steam is similar to a pressure reducing station. It is common that the discharge steam flow from the SJT Steam Jet Thermocompressor contains some superheat. Depending on how the discharge steam will be used, there is an opportunity to use a Spirax Sarco Desuperheater to reduce the outlet superheat.

To avoid complications with design and installation, Spirax Sarco recommends that a Desuperheater is installed after the SJT Steam Jet Thermocompressor.

Use the Online Calculation Software and the discharge steam conditions shown on the SJT Steam Jet Thermocompressor Datasheet as the inlet conditions to the Desuperheater, and size as normal.



Maintenance

Maintenance of an SJT Steam Jet Thermocompressor is simply a matter of fitting a spare nozzle to the unit at certain time intervals, with these intervals depending on the nozzle material used and the steam condition.

The material chosen by Spirax Sarco in the manufacture of the steam nozzles for all of their SJT Steam Jet Thermocompressor's have a history of delivering longevity in their application. As nozzle wear is usually a very slow process, it is recommended that nozzle wear be monitored through a planned maintenance programme.

How to order

Example: 1 off Spirax Sarco Size 6 SJT150CS Steam Jet Thermocompressor having ASME 300 RF slip on flange connections.

Note: Attach the SJT Datasheet to the order.