SRI Jigger Tubes System

Design, Installation and Commissioning Manual

(Abbreviated Version)

INDEX

This manual details how the SRI Jigger Tubes System can be tailored to suit the needs of a variety of vacuum pans. It provides:

1. Overview of the SRI Jigger Tubes System

1.1 Key distinguishing features

The SRI Jigger Tubes System is distinguished from traditional jigger pipe installations in these important ways:

- The Jigger Tube perforations are small enough to eliminate back-flow of molasses or massecuite, avoiding:
  - The need for non-return valves in pipework.
  - Blockages of pipework and valving.
- A wider distribution of very small bubbles resulting in:
  - Better circulation improvement.
  - Minimal risk of tube plate erosion.
- The SRI system utilises incondensible gases withdrawn from the calandria of the pan, which places little or no extra load on the condenser. (Alternatively, process steam or vapour may be used.)

1.2 Physical characteristics

The SRI Jigger Tubes System has the following characteristics:

- Jigger Tubes are 316 stainless steel, 76.2 mm OD, 1.6 mm wall thickness.
- Perforations are 0.2 mm diameter with ~ 100,000 holes per lineal metre of tube.
- Standard tube length 1,500 mm.
  - Shorter lengths are quoted and supplied on an individual project basis.
  - Length recommendations for specific pans allow for cutting and welding, joining to flanges, etc.

1.3 Operational characteristics

The SRI Jigger Tubes System is typically fed with incondensible gases withdrawn from the calandria gas venting system. The Jigger Tubes are positioned under the calandria, in a pattern designed to distribute a multitude of small gas bubbles into the massecuite over a wide area, at a position that maximises the enhancement of the massecuite circulation.

Alternatively, instead of incondensible gases, process steam or vapour can be supplied directly to the Jigger System. In this manual, for the sake of simplicity, the gas feeding to the Jigger Tubes is called “Jigger Gas” – regardless of whether its source is incondensible gas (with perhaps some vapour) from the calandria; or process steam; or vapour from another source.

Commissioning and control are simple. Once the system is commissioned by adjusting the position of a manual regulating valve it does not need to be re-adjusted. No additional control elements are required.

1.4 Replacement for existing jigger systems

Some poorly performing or key production pans will already have a jigger system installed. Most such systems inject the Jigger Gas in localised regions with limited distribution. This sometimes causes erosion of the tube plate and calandria tubes above the jigger feed locations.

The SRI Jigger Tubes System can be installed as a replacement system, providing better distribution of the Jigger Gas and reducing the erosion of the bottom tube plate and calandria tubes.

2. Design and Installation Guidelines – Batch Vacuum Pans

In vacuum pans, a strong circulation flow allows the pan to be controlled closer to the optimal supersaturation level and provides benefits in productivity, product sugar quality, and efficiency. The diagram below shows how the injection of Jigger Gas in the region underneath the calandria will boost the natural circulation.

The SRI Jigger Tubes System is designed to inject Jigger Gas in order to enhance circulation in locations where it is generally poorest: i.e. towards the outer periphery of the pan, where there is also the greatest surface area available for heat transfer (refer Figure 2.1).

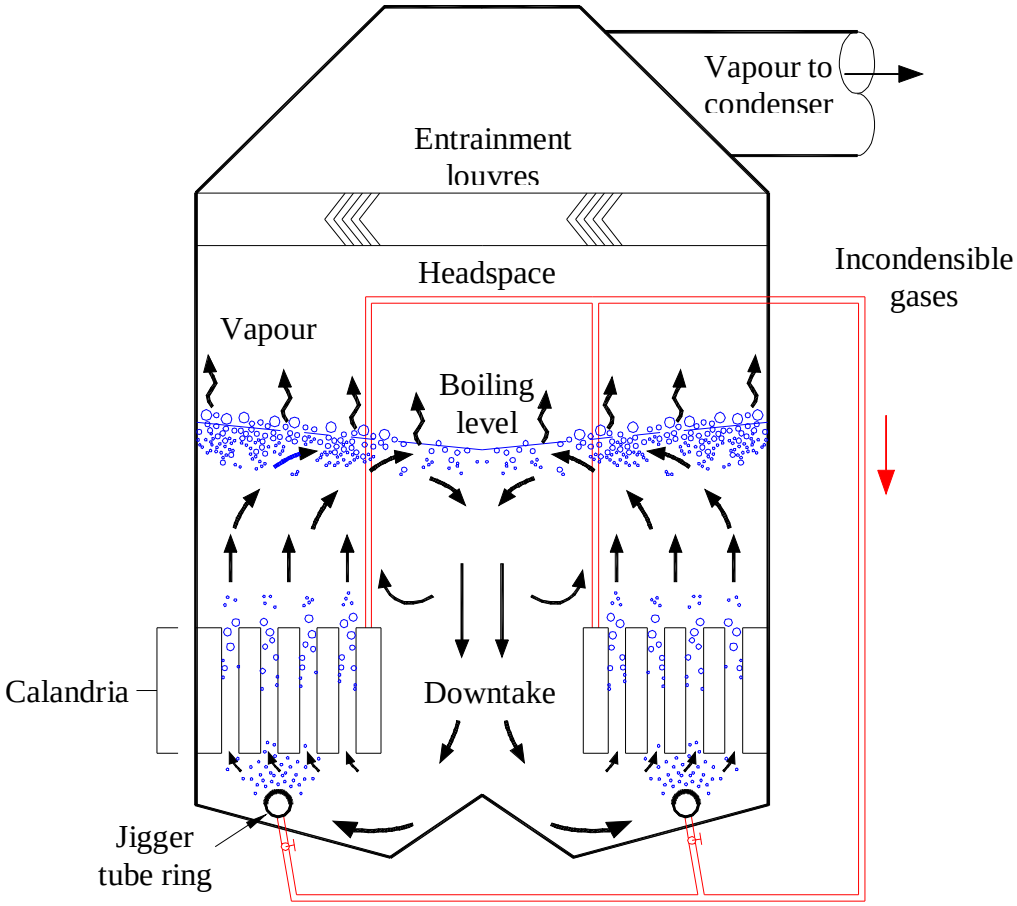


Figure 2.1 Illustration of the benefits of the SRI Jigger Tubes System on circulation in a batch pan.

Design guidelines are:

- Jigger Tubes are constructed from straight tube lengths to form a polygonic ring, located underneath the calandria.
- The pitch circle diameter (PCD) of the ring should be about 66-75% of the distance across the calandria, from the downtake wall.
- The length and number of sides to the ring can be modified to suit.

- One Jigger Gas inlet is required per 6 to 8 metres of Jigger Tube. For multiple Jigger Gas inlets, these should be equi-spaced around the ring.
- Location of the tubes should allow 50+ mm gap between the underside of the tubes and the pan floor, to facilitate discharge of massecuite.
- Location of the tubes should allow 140+ mm gap between the top side of the tubes and the bottom of the calandria, to facilitate adequate lateral dispersion of the bubbles.
- The piping inlets to the Jigger System will provide support for the tubes. However other supports will be required, to secure the Jigger Tubes above the pan floor. These can be bolted or welded in place.
- No condensate outlets are required for the Jigger Tubes.
- In advance of installation into the vacuum pan, the prefabricated Jigger Tube ring sections should be assembled outside the pan to check for correct fit and to confirm correct locations for cutting inlet holes into the base of the pan.

Three diagrams follow to show recommended arrangements for installing the SRI Jigger Tubes below the calandria of batch pans:

Figure 2.2 shows the preferred (recommended) arrangement where the jigger ring is constructed in four flanged sections and attached to two flanged inlets. The pan shown in Figure 2.2 was a pan of 69 m^3 massecuite volume (5.8 m diameter).

Figure 2.3 shows an alternative arrangement, where the Jigger Tubes are welded (instead of flanged) at the inlets.

The installation of the Jigger Tubes System must not interfere with syrup/molasses feed inlets. Figure 2.4 shows an arrangement where the Jigger Tubes are on a similar PCD to the syrup/molasses feed inlets.

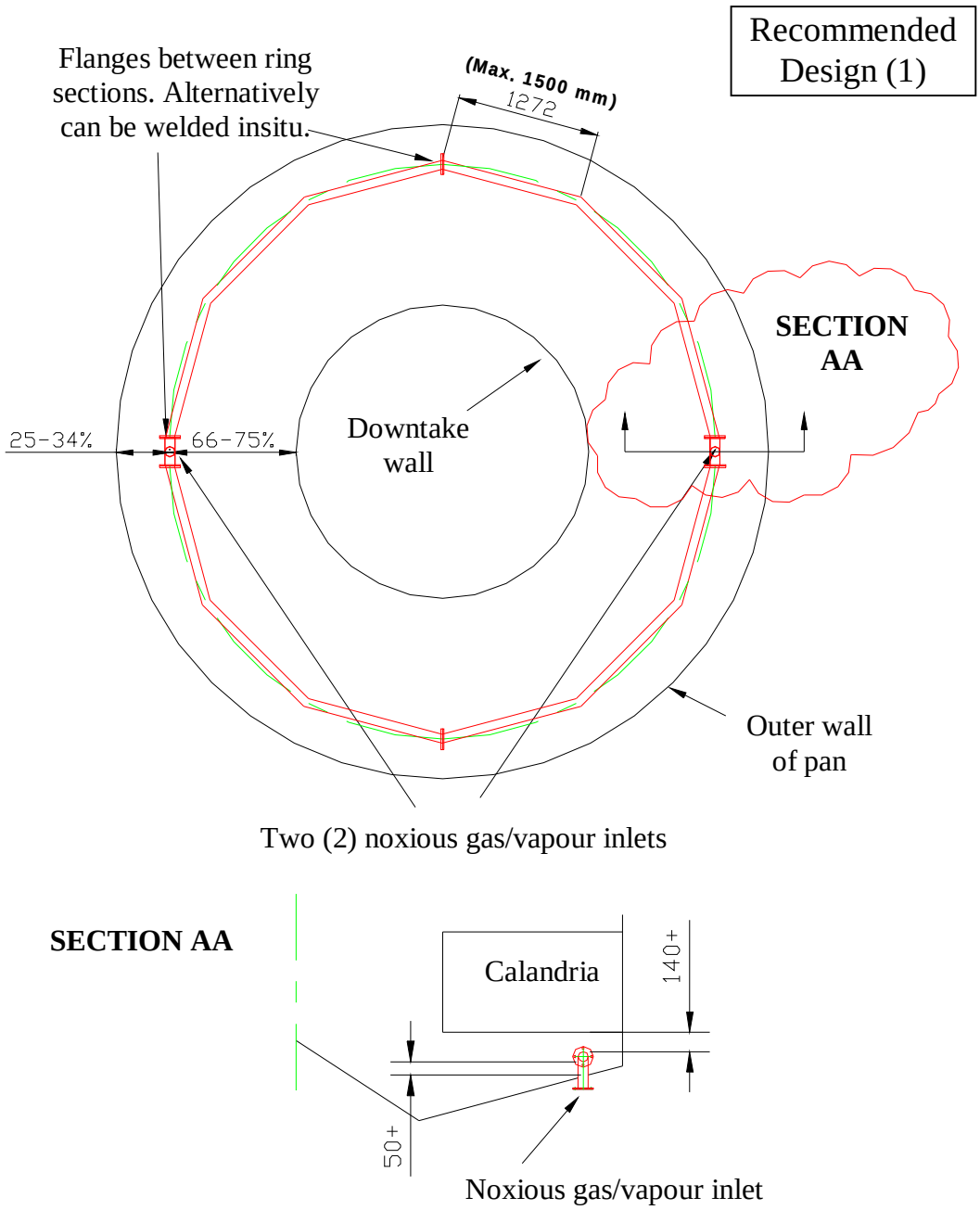


Figure 2.2 Preferred (recommended) arrangement for the Jigger Tubes installed in a batch pan.

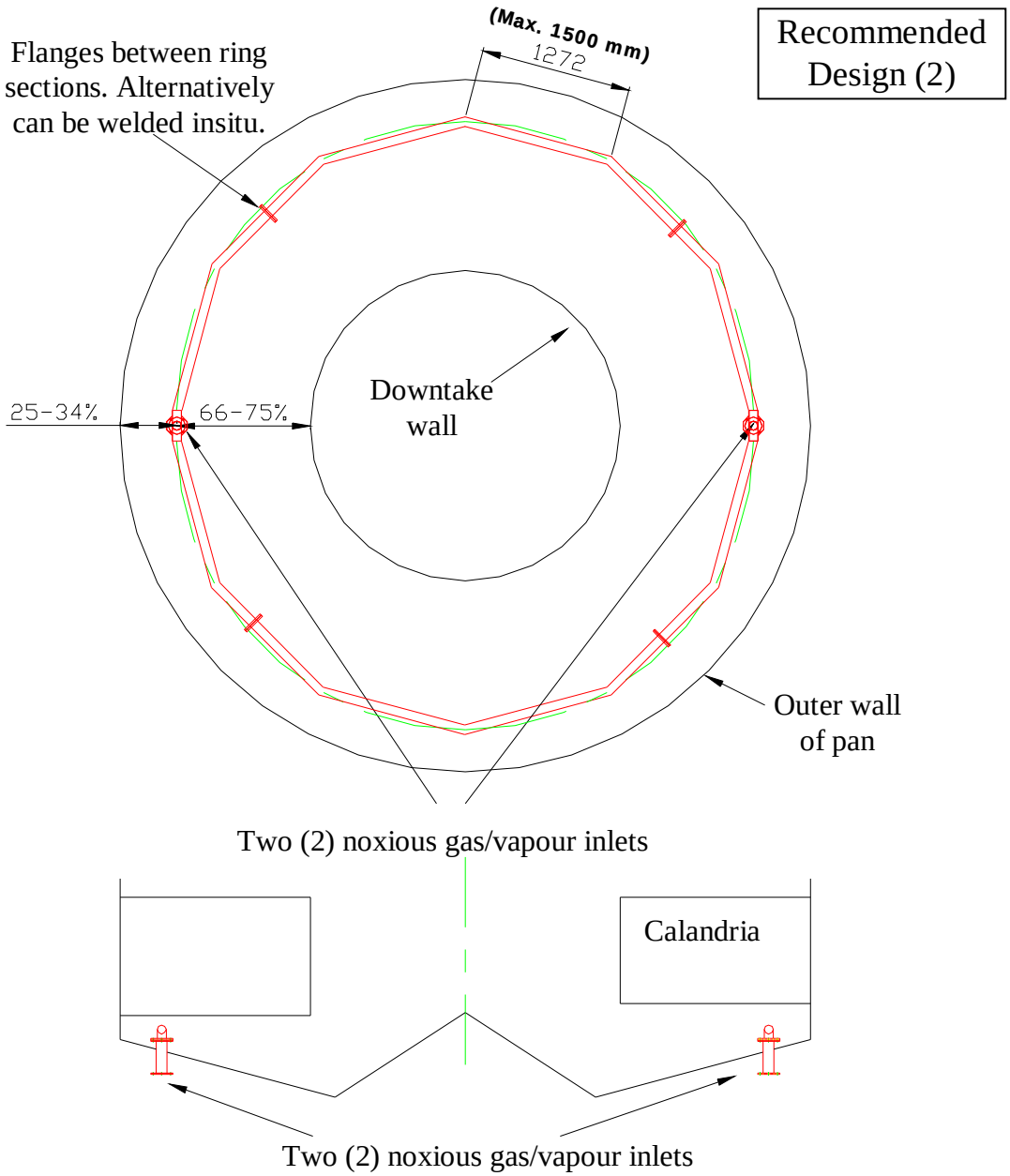


Figure 2.3 An alternative arrangement for the Jigger Tubes installed in a batch pan.

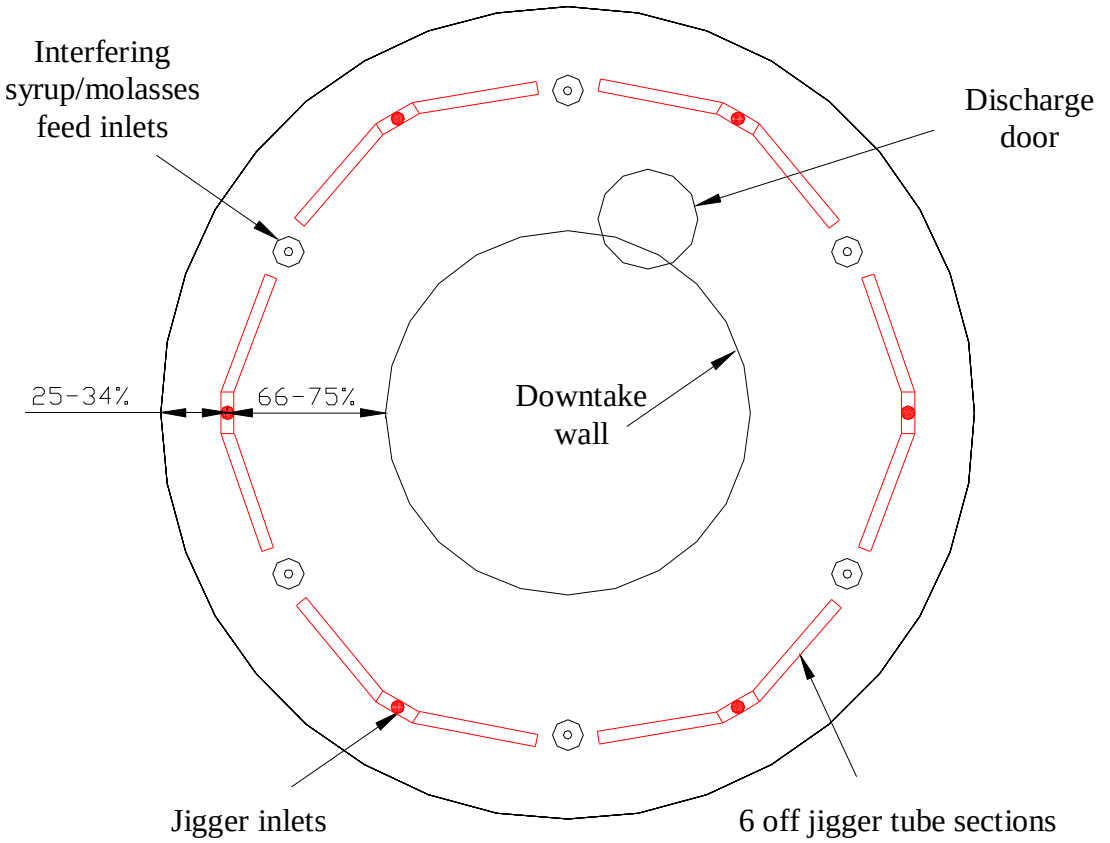


Figure 2.4 The recommended arrangement for installing the Jigger Tubes System into a batch pan where the PCD of the syrup/molasses feed inlets is similar to the PCD of the Jigger Tubes.

3. Design and Installation Guidelines – Continuous Vacuum Pans

Design guidelines are:

- Jigger Tubes are typically installed as tube lengths joined end-to-end by welding (except for flanged joints at the Jigger Gas inlets).
- One or two rows of Jigger Tubes are installed underneath the calandria, close to the centreline.
- Where a longitudinal partition divides the compartments, a row of Jigger Tubes is located on each side of the partition, at 12-15% of the distance from the pan centreline to the outer edge of the calandria.
- One Jigger Gas inlet is required per row, per 6 metres of row length. For longer rows, additional inlets should be provided.
- Where baffles which separate cells interfere, cut a neat hole in the cell wall to accommodate the Jigger Tubes and secure the tubes to prevent vibration.
- The Jigger Tube rows can be welded within the cell. Flanged sections should be prepared outside the pan.
- Interference with syrup/molasses feed inlets, or with massecuite transfer pipes for draining, can be overcome by positioning the rows of Jigger Tubes around them.

Two diagrams follow, which show the recommended arrangements for installing SRI Jigger Tubes below the calandria of continuous vacuum pans.

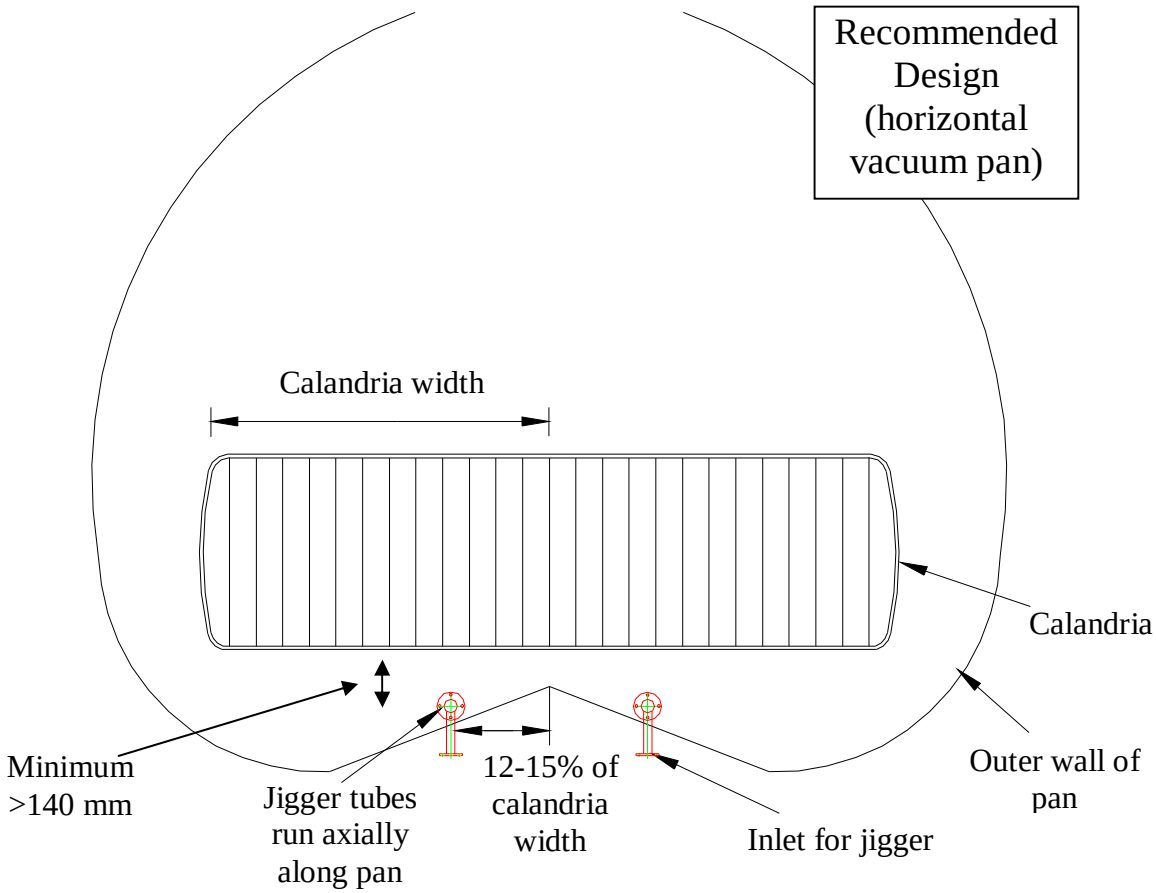


Figure 3.1 Recommended arrangement for installing the Jigger Tubes System into the base of a horizontal continuous pan with vertical tube calandria.

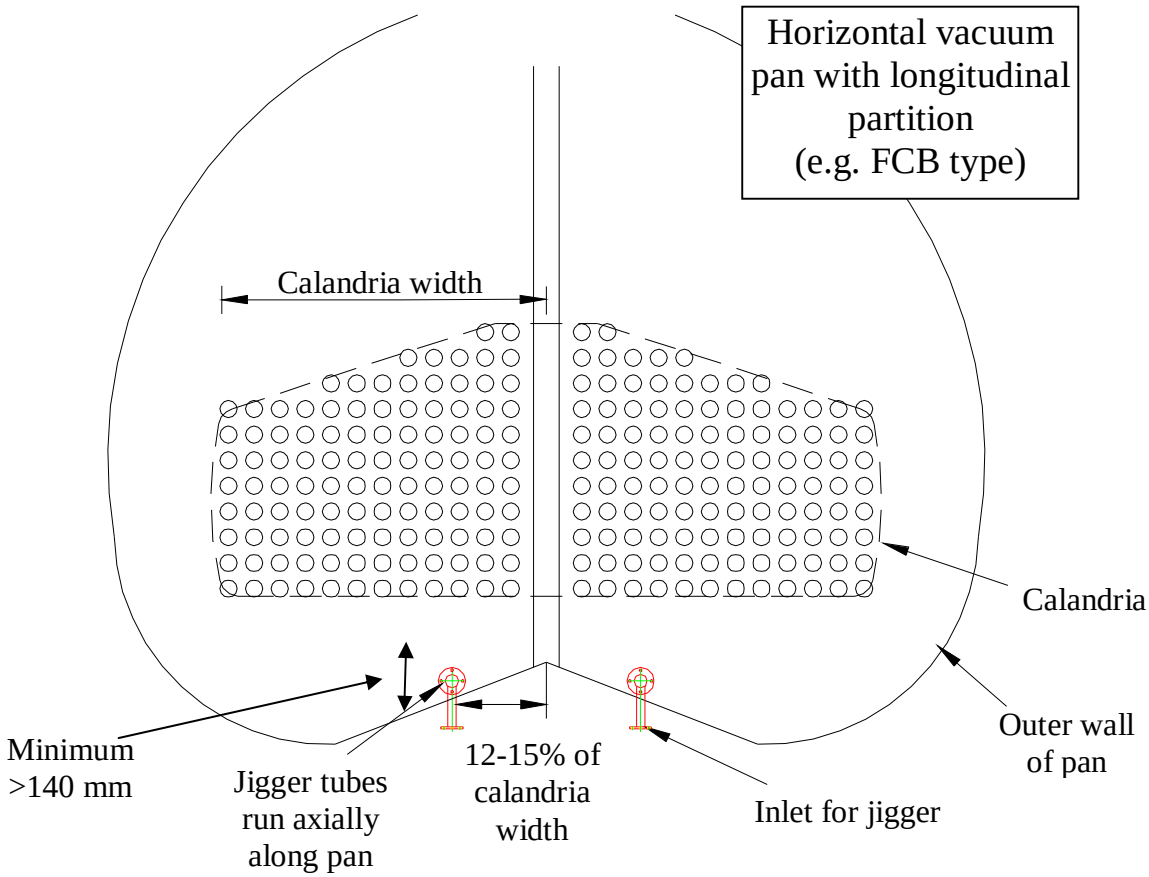


Figure 3.2 Recommended arrangement for installing the Jigger Tubes System into the base of a FCB continuous pan.

4. Design of Jigger Gas Inlet Connections

The most common arrangement for installing the Jigger Gas inlets to the SRI Jigger Tubes System is illustrated below. This is the arrangement shown in Figure 2.2, Figure 3.1 and Figure 3.2.

- The client will be advised of the required diameter of the Jigger Gas piping to transfer the Jigger Gas from the calandria to the Jigger Tubes. This size will depend, among other things, on the length of the pipe run.
- The T piece for each Jigger Gas inlet may be 80 x 80 x 80 mm or 80 x 80 x 65 mm, depending on the required diameter calculated for the Jigger Gas feed piping (80 mm or 65 mm). The tee section through the pan floor may need to be extended by welding a pipe section of the same diameter.
- Use standard gaskets suitable for low pressure steam.

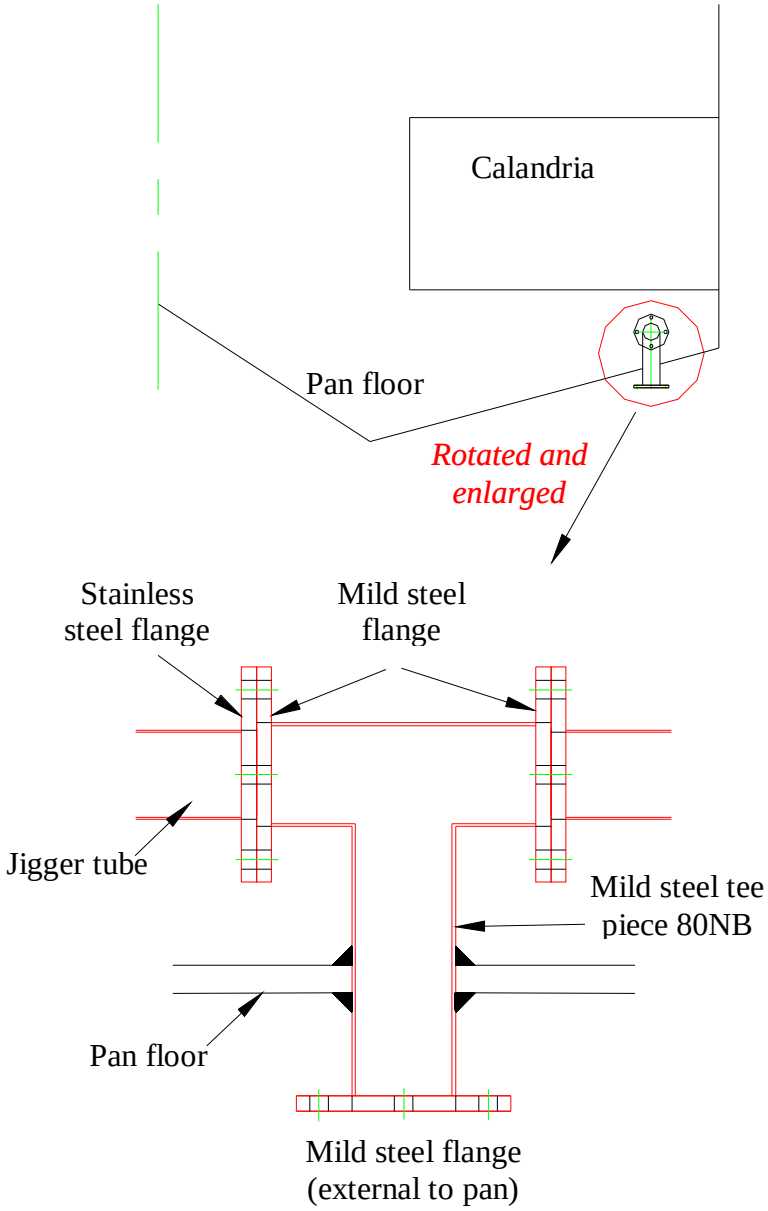
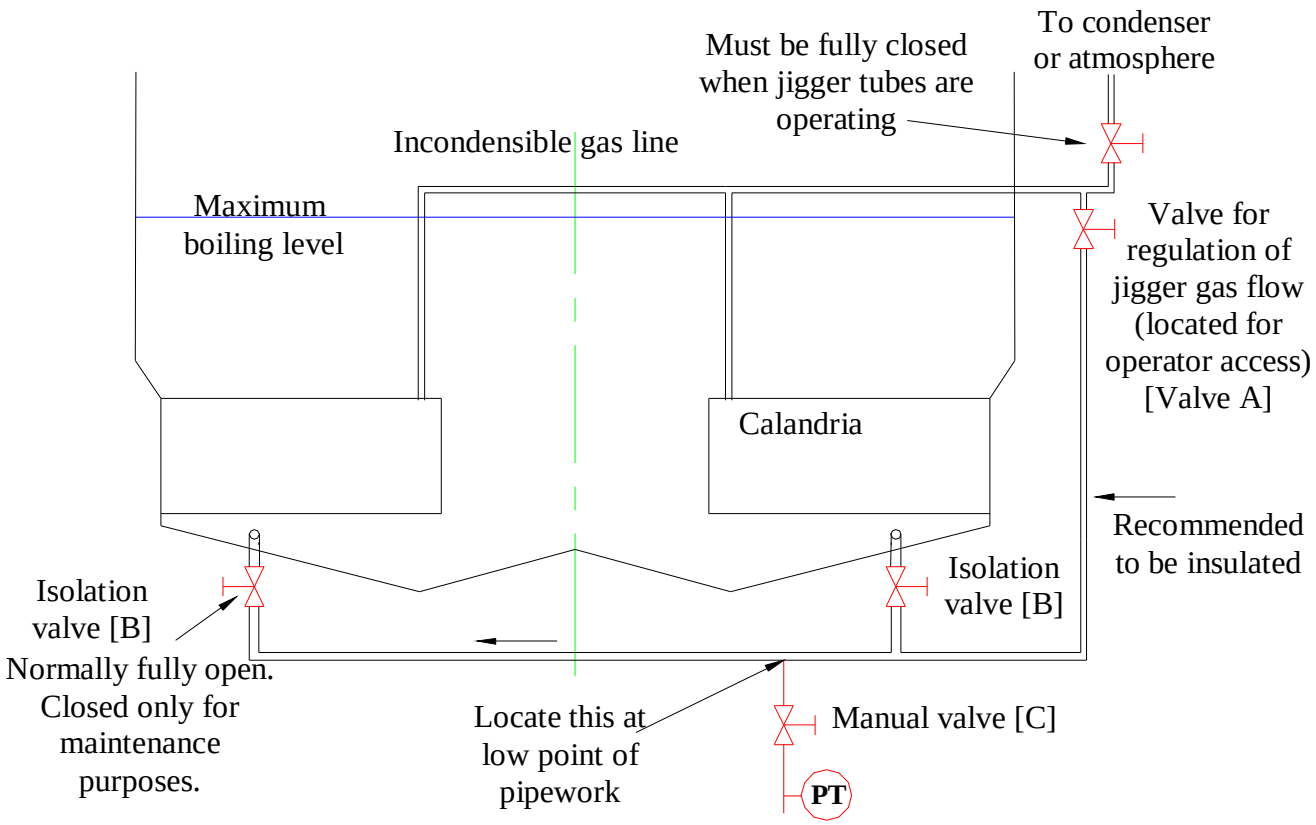


Figure 4.1 Details for installing the inlets of the SRI Jigger Tubes System.

5. Design and Installation of Jigger Gas Piping & Valves

Typical layout for piping the Jigger Gas from the calandria to the Jigger System is shown below. The example shows a Batch Vacuum Pan. The arrangement for Continuous Vacuum Pans is similar.



Valve A – Manual globe or gate valve
Valve B – Manual ball valve
Valve C – Manual ball valve (25 DN)

Figure 5.1 Recommended valving and instrumentation for the SRI Jigger Tubes System.

6. Control and Setting of the Jigger Gas flow

The description below refers to setting of the Jigger Gas flow for a fixed calandria batch pan. The procedures are similar for other installations (e.g. for horizontal continuous pans). Refer to Figure 5.1.

The flow rate of Jigger Gas is regulated by the manual globe/gate valve (Valve A) set to an appropriate number of turns. A pressure differential of 10 to 20 kPa (between the Jigger Gas inlet and the pressure within the massecuite at the base of the pan) should give an adequate flow. The isolation valves for the inlets to the jigger system at the base of the pan (Valves B) should always be fully open, except when required to be closed for maintenance reasons.

During commissioning, the manual regulating valve (Valve A) should be adjusted to the setting that ensures:

- All incondensible gases are withdrawn from the calandria steam chest; and
- The quantity of vapour withdrawn with the incondensible gases is not excessive.

There is no easy way to assess this but a pressure differential of 10 to 20 kPa as mentioned above should be appropriate.

The procedure for setting the Jigger Gas flow is as follows:

1. Calculate the Target Jigger Gas Pressure (P_{jigger} - as described in Appendix "A") required to achieve 15 kPa pressure differential across the Jigger Tube perforations.
2. The pan should be boiling massecuite at the normal operating vacuum.
3. Open the jigger system isolation valves (Valves B) below the pan (fully open).
4. Open the valve (Valve C) at the pressure tapping and check a vacuum exists at this point.
5. Close the valve (Valve C) and connect a pressure transducer/gauge. The transducer should be suitable for measuring sub-atmospheric pressures.
6. Through sight glasses on the pan, observe the boiling action and movement of massecuite at the boiling surface from above the calandria to the downtake.
7. Close the valve which vents the incondensible gases from the calandria to the headspace, condenser or to atmosphere. Then open the manual regulating valve (Valve A) a few turns.
8. Observe the boiling action of the massecuite through the sight glasses. The injection of the Jigger Gas will not cause a massive eruption of massecuite. The changes will be relatively gentle, but an improved circulation flow in the massecuite will be evident.
   Note: At higher operating levels in batch pans the main circulation path is below the massecuite surface and circulation changes will be less visible through the sight glasses.
9. When the batch pan is at the full condition and is nearing completion, re-adjust the manual regulating valve to achieve the target P_{jigger}. The setting of the valve (number of turns of opening) should be determined and noted. If possible, examine the boiling action in the pan (generally difficult when batch pans are full).
10. Leave the manual regulating valve at its current setting and leave the Jigger System isolation valves (Valves B) fully open.

11. For the next cycle of the batch pan observe the boiling in the pan with the manual regulating valve at this same setting. If the boiling action looks satisfactory then the commissioning of the Jigger System is completed.
12. If further adjustments are thought necessary, repeat the set up procedure to achieve a Jigger Tube pressure differential greater than (or less than) 15 kPa, as required. For example, operation with a 20 kPa difference in pressure could be trialled to select the preferred operating set up.
13. Close valve C and remove the pressure transducer/gauge. Valve C is now a suitable point to drain any condensation during a maintenance stop.

Note: For horizontal continuous pans the Jigger System will operate effectively at a lower pressure difference across the perforations (e.g. 10 kPa difference in pressure may be sufficient).

Automatic control of the pressure differential is not required and once the appropriate setting of the manual regulating valve (Valve A) is determined there is no need to change the setting of this valve.

The isolation valves (Valves B) on the Jigger Gas feed inlets should be left fully open except for exceptional circumstances, e.g., pan shut down during a maintenance stop.

Appendix "A"

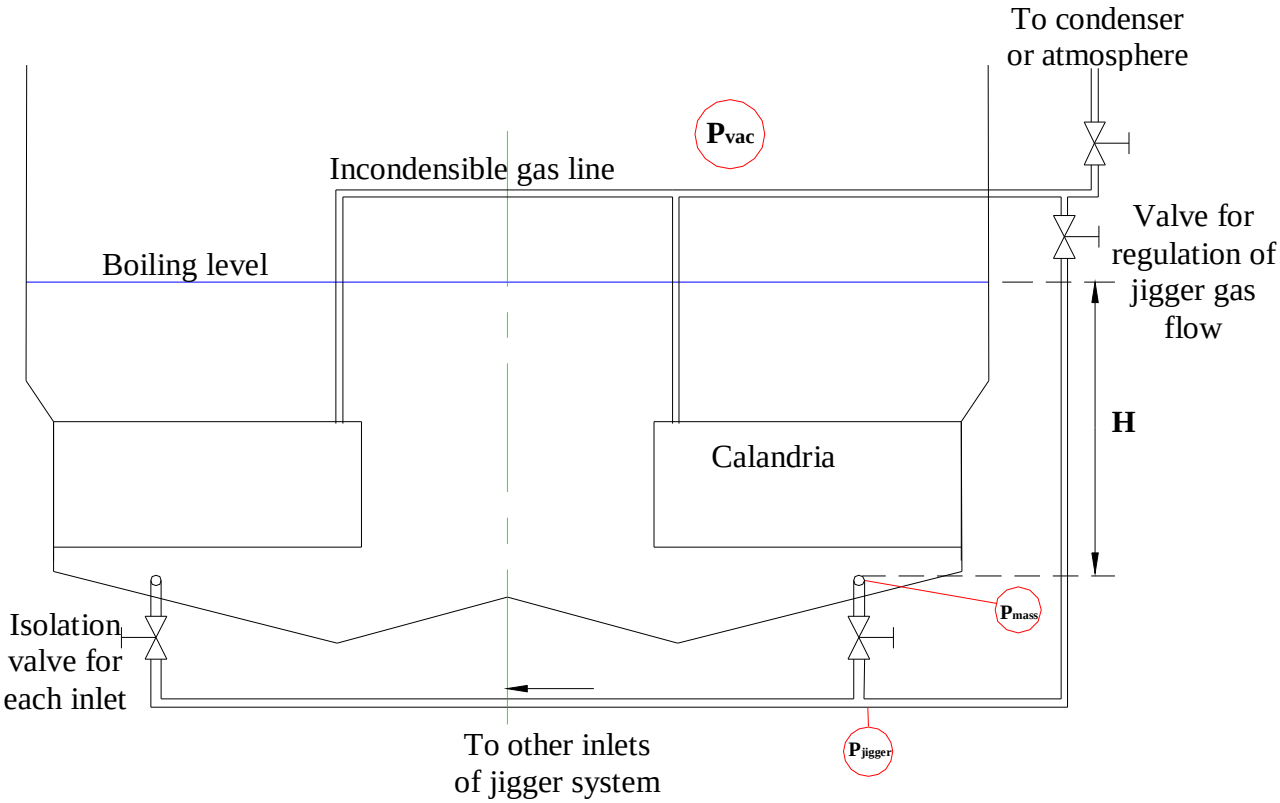
Calculation of Target Jigger Gas Pressure to achieve 15 kPa pressure differential

For a pressure difference of 15 kPa across the Jigger Tube perforations:

P_{jigger} = 15 kPa + P_{mass}

P_{mass} = P_{vac} + (1.45 t/m^3 x 9.8 m/s^2 x H m.)

where P_{vac} = head space pressure in vacuum pan (kPa absolute)



For example, for P_{vac} = 17 kPa absolute and **H** = 2.8 m

P_{mass} = 56.8 kPa abs.

Target P_{jigger} = 71.8 kPa abs. (to achieve 15 kPa pressure difference across the Jigger Tube perforations)