

Simple Modifications For Better Results From Rotary Vacuum Washers

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Rotary Vacuum Washers

In its simplest form, the rotary vacuum washer consists of a hollow horizontal drum partially immersed in a vat of stock. The curved surface of the drum is perforated and covered with a filter cloth or wire (or some other filter medium). Vacuum can be applied to the inside of the drum to promote the filtration process. Usually there is an arrangement whereby the vacuum is applied separately to various longitudinal sections of the filter area.

As described so far, the device is the same as the drum filter, which is widely used in many other sections of the process industry. However, the operation of the device in the pulp and paper industry is quite different from most other applications and this results in some special design features:

- The solids content of the feed slurry (stock) and discharge cake (pulp sheet) are much lower than in other applications. This results in a much larger filtrate to solid product ratio than is normal.
- The drum is submerged to a greater extent than in most applications.
- The fibrous nature of the solids often results in a cleaner filtrate than can be achieved in other applications.
- In most applications the filtrate is either removed via a barometric seal leg, or is passed to a receiver from whence it is pumped away, and air that has been drawn through the cake is removed separately. In a pulp washer, the filtrate and air are removed together through a drop leg.
- In most applications the vacuum is applied by means of a vacuum pump, but with a pulp washer the vacuum is usually induced by means of the rotation of the drum and the correct action of the drop leg.

Unfortunately, the significances of these differences are often improperly understood, and this results in standard performance.

The difference between drop legs and barometric legs

One of the most important features of the rotary vacuum washer is the drop leg, and failure to design or install this properly can result in a very substantial loss of performance. Unfortunately, inappropriate drop legs are frequently encountered, and these often arise because people have failed to distinguish between the functions of drop legs and barometric legs, and they even use the same term to describe both devices

This difference between drop legs and barometric legs is illustrated in Fig 2 and can be regarded as the difference between a static and a dynamic device. A barometric leg

Introduction

Until comparatively recently, the most commonly encountered type of pulp washer in most mills were Rotary Vacuum Washers (Figure 1). Also widely used were related types of equipment including deckers, stock thickeners and some types of saveall. Although other types of equipment are now often used, a large number of units of these types remain in use. However, experience shows that many of these units are operating well below their potential capacity as a consequence of poor original installation, inappropriate modifications or changes in duty without adjustment to the equipment.

In this paper we discuss some simple checks which can be made on the operation of the filter and suggest some inexpensive measures, which may be taken to correct deficiencies.

can be regarded as an arrangement working at low velocity so that gases cannot be entrained by the liquid flow, but a drop leg is a dynamic device whereby the liquid velocity is sufficiently high to entrain the gases and transport them to the liquid discharge.

In the barometric leg, most of the air entrained in the filtrate is separated out and removed by a vacuum device. The substantially air-free filtrate then flows down the barometric leg at relatively low velocity (use of a high velocity would result in high friction losses and the 'wasting' of part

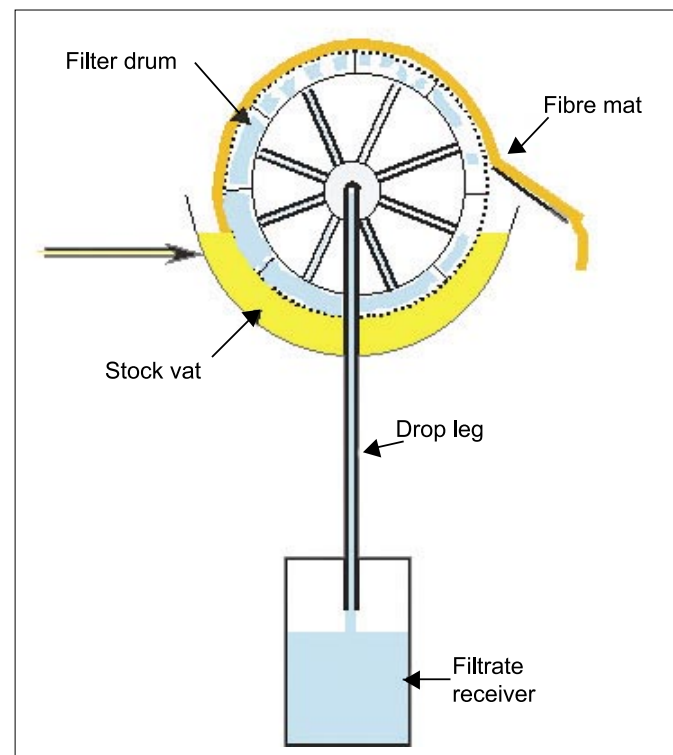


Figure 1 Schematic view of a rotary vacuum washer

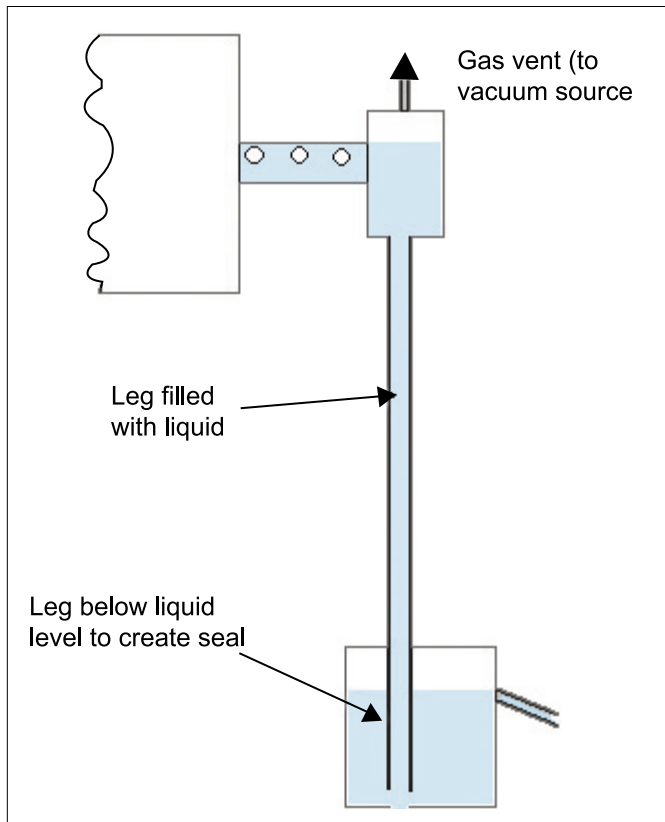


Figure 2(a) Barometric leg

of the available hydrostatic head). Submergence of the lower end of the leg in a seal pot prevents air ingress up the barometric leg.

With a drop leg, care is taken to avoid segregation of entrained air and filtrate. Instead, the filtrate flows down the drop leg at a sufficiently high velocity to ensure that it carries the air with it, and the air and filtrate are discharged together at the bottom of the drop leg. This has several implications:

- The diameter of the drop leg cannot be too large, as the filtrate will then dribble down the sides and not entrain air.
- The diameter also cannot be too small, as this will restrict the flow of filtrate and air.
- If the feed to the washer vat needs to be diluted, the dilution should produce a reasonably constant filtrate flow. It is counterproductive to vary the vat dilution with the production rate.
- The drop leg should preferably not be submerged at the discharge end, as this reduces separation capacity.

There are various recommended figures for sizing the drop leg diameter. They are usually in the range 3-6 m/sec superficial velocity where superficial velocity = filtrate flow (m³/sec)/pipe cross section area (m²). The low velocities are for small pipe diameters and vice versa. TAPPI has been issuing guidelines for leg sizes since 1939 (ref 8). Other data on the sizing of barometric legs is given in refs 1-7, 8, 9. For most purposes superficial velocities in the range 2.8-4.2 m/sec are suitable. It is generally recommended (e.g. ref 4) that within the acceptable range, as high a velocity as practical should be employed, but this of course does restrict the potential for increase in throughput without signifi-

cant loss of pressure.

It is sometimes suggested (e.g. ref 4) that vacuum can be improved by injecting high velocity filtrate into the top of the drop leg so as to accelerate the mixed stream. In practice this often does not produce the required result. It is possible that this is because the geometric arrangement is quite critical and is often ignored in practice. It is also possible that installations which really benefit are those with oversized drop-legs and that the main benefit of the filtrate addition is to restore the drop-leg velocity to an appropriate value (replacing the drop-leg with one of the proper size would probably be a cheaper solution). One situation in which the use of filtrate injection may be useful is where the washer is regularly operated at high turn-down. In this case provision to inject filtrate may improve performance, **provided that** the filtrate flow is turned on at low flows **and** turned off at high flows.

Checking out the system

There is no value in making any substantial changes to the system, or even trying to determine its performance, until it has been established that the filter is in good repair.

A simple visual inspection can reveal a lot:

- Are all of the washers sprays running properly. It is not uncommon to find spray bars with some nozzles blocked or missing? We know one pulp washer which ran for several years with one wash bar turned off because a displaced nozzle squirted water over a walk way (no-one regarded this as sufficiently important to repair the nozzle or to fit a deflector plate).
- Is there an obvious streak around the washer where the sheet is wetter (or drier) than elsewhere? This may be an indication of poor wash water distribution, or of problems with the stock feed, the cloth or the drum internals

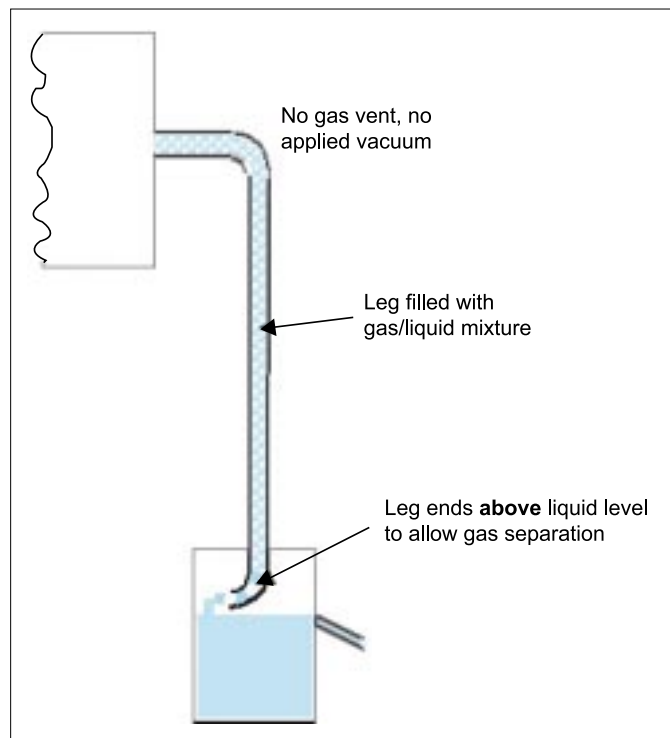


Figure 2(b) Drop leg

- If one section across the drum is particularly wet, or rather thin this indicates a blockage in the filtrate channel inside the drum.
- Is the cloth dirty or badly worn? Performance will be poor in this case.

The internal condition of the filter is very important. Worn or damaged seals will result in loss of performance and solids that have passed through the filter cloth may eventually form deposits, which restrict filtrate flow. Unfortunately, it will not usually be practical to investigate such matters prior to performing a review of filter performance.

Stock distribution in vat

Before any other work is undertaken, it is important to establish the uniformity of stock concentration across the width of the filter vat. If the stock is not of uniform consistency across the vat, the sheet will form with an uneven thickness and as a result the filtrate removal rate, the wash water removal and ultimately the air ingress will all vary across the width of the washer. This results in the sheet moisture and chemical content varying across the width of the washer, and more importantly, the average moisture and chemical content of the sheet are higher and the washer capacity is lower than if a uniform vat consistency is employed.

The dimensional proportions of the vat are such that the vat agitator cannot induce large scale mixing across the width of the vat. Therefore, feed is introduced at several positions across the width of the vat. Ideally the feed pipes would be of a symmetrically branching type, but to reduce costs an inherently less uniform feed pipe arrangement that delivers varying quantities of stock across the vat is often used.

If an uneven stock distribution is found, the ideal solution is to alter the inlet-piping manifold to give a more uniform stock distribution. However, unless the situation is very bad, this will not be considered to be economical. In such situations the appropriate addition of orifice plates or other restrictions in some of the branches can improve matters considerably.

Just as important is the means of addition of dilution water upstream of the filter vat. Dilution water **must** either be added well upstream so that adequate mixing occurs before the vat, or it must be added in a way that any non-

uniformities are split evenly across the various branches to the vat. This means that either a concentric-pipe arrangement must be used or the dilution pipe must enter perpendicularly to the plane in which the vat feed line branches. Unfortunately, there is no simple fix to this problem (such as using orifices to compensate for poor manifold design). If the stock dilution pipework is inappropriate it must be fixed.

How is the drop leg run?

To achieve optimum performance, the direction of run of the drop leg is also of considerable importance. The drop leg should be vertical. Any section at an angle to the vertical allows the air to separate from the filtrate, and this will affect the performance of the drop leg and washer. If the inclusion of a 'jog' in the leg is unavoidable it should be as far below the washer as possible and it should be restricted to vertical and

horizontal sections, inclined sections of line can have devastating effects on washer performance as they permit complete separation of the water and gas phases. Almost always it is better to move another service than to bend the drop leg (we saw one washer where the drop-leg was snaked to bypass a cable tray (despite the fact that electrons can go round corners quite easily!). When the drop-leg was straightened the consistency of the pulp mat increased from 10% to 13%.

Although the drop leg should be run vertically, it is occasionally necessary to position the filtrate tank far away from directly beneath the washer. Provided that the full drop is taken first, it is possible to have a very long horizontal line leading into the filtrate tank. In such cases (contrary to practice elsewhere) the line should slope **slightly** uphill towards the discharge to ensure the removal of any air, which separates out.



Left: Geoff Covey Right: Reg Harvey

Overloading of washers

This is quite common in the industry, as it is not possible to increase the surface area of drum washers if production increases. The mill has to live with the overload, or install a new washer. This is not cheap. Bleach plants often have several washers, and these normally have the same dimensions. In this case the situation is worse, as all the washers should be replaced if the throughput rises significantly.

Under favourable circumstances e.g. washing of high freeness chemical wood pulp and non foamy filtrate, the rule of thumb is that throughput = 10 OD t/d per m² of cloth area. For other situations, the throughput is considerably lower. It is well worthwhile to check the actual loading on a washer before deciding on modifications.

Usually it is desirable to run rotary washers at as low a rotation speed and as high a vat level as possible, as this will give the best performance. If it is necessary to increase washer throughput, some capacity gain can be made by increasing drum speed, albeit at the cost of poorer performance. A danger is that the high drum speed will be maintained when throughput is reduced again, and this will lead to excessive air entrainment.

The stock temperature and the wash water temperature will influence the filter capacity. The flow of filtrate through the cake is laminar so pressure drop will vary inversely with the filtrate viscosity. This effect is very noticeable on belt filters. If the filter is started up on cold stock, the throughput is low, but will increase quite markedly as the temperature increases. There is of course, a limit to how hot the stock and wash water can be without the vapour pressure of the water significantly reducing the available vacuum. Typically washers will operate with a vacuum of 20-30kPa (although many operate at a much lower vacuum, usually because of poor drop-leg design). Therefore, much higher temperatures can be used in pulp washers than in other vacuum filters, which operate at higher vacuums. An optimum temperature of about 65°C (slightly higher for hardwoods and slightly lower for softwoods) has been suggested (ref 10).

Condition of drum internal seal

Poor performance may be related to

deterioration of the washer drum internal seal. Maintenance of this is a fairly major task that requires quite a lot of downtime and lost production. If work is required inside the washer, even more downtime is required. There is a tendency to postpone the maintenance until the situation becomes desperate.

Cloth/fabric cleaning

This is important particularly for mechanical pulps and recycle paper containing a lot of fines/stickies etc. The two most important points are to keep the cleaning spray nozzles unblocked, and to have an adequate pressure in the spray nozzles. Manufacturers have recommended pressures for sprays, and these should be adhered to. We know of one case where a saveall was performing very poorly. The spray pressure was less than half the manufacturers recommendations. Increasing the spray pressure gave a dramatic improvement in performance.

Common problems with washers

A few types of problem are very commonly encountered, and some of these are discussed here. Poorly designed drop legs or drop legs that have been modified in a manner, which reduces their effectiveness. Typical deficiencies include:

- Excessive submergence of the leg in the filtrate receiver. As noted above, it is not necessary to submerge the discharge end of the filtrate line, although a small amount of submergence will not affect the performance much at all (some customers feel reassured by this!).
- Unnecessary bends and changes of cross-section in the leg.
- Sections of leg which allow air separation
- Improper use of multiple legs from a single filter.
- Too high or too low a drop leg velocity

Disc savealls operate in a similar fashion to drum washers (or more precisely to drum thickeners). They have a clear and cloudy leg, with a typical filtrate split of 30% to the cloudy leg, and 70% to the clear leg. The split is determined by the position of the bridge. The authors know of one instance where the bridge was installed the wrong way round, and had been run that way for some time.

Conclusion

Although drum washers are not commonly installed in new operations, they are simple, effective and have a long working life – as evidenced by the large number of old units still in service. However, many of these units were installed incorrectly, have been modified inappropriately, have been poorly maintained or have had their duty changed without adjustment of the washer. As a result many units perform poorly.

If your mill has such a unit, do not immediately replace it. First check how it is configured and operated. A very small investment may result in big improvements in its performance. (Needless to say, Covey Consulting, or Covey Consulting Malaysia will be pleased to assist you in such investigations)._PA

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