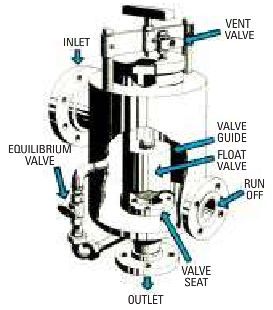
PROCESS MEASUREMENT & ANALYSIS LTD

BELFIELD DECANTATION VALVE



DESCRIPTION:

The Belfield valve has been acclaimed, *the easiest, most efficient way* to decant and recover a wide variety of liquids possessing different specific gravities! It is automatic, extremely sensitive, versatile and provides users with a proven method for decanting or separating the heavier of two liquids. It also eliminates the many problems which occur during manual decanting of one phase in a wide range of multiphase systems, including:

a. loss of product due to human error, especially where little or no colour variation exists between phases.
b. detects and retains or rejects valuable interface materials containing recoverable products.
c. serves as a safety device on effluent discharge systems reducing and/or eliminating pollution problems.
d. requires minimal attention, service and maintenance thereby reducing labour costs drastically.
e. Standard body materials of construction are either carbon steel or stainless steel, in both cases the internals are constructed from stainless steel.

Operation:

The operation of the Valve is based on the simple principle of differential specific gravity.

One phase is discharged through the internal Float Seat. A change of specific gravity automatically closes the valve the Float Valve. The side run off permits discharge of the second phase, together with any deliberately retained interface material.

Test results show the Belfield Decantation Valve is capable of detecting variations in specific gravity of 2% on average, and in favourable circumstances greater accuracies are possible.

VALVE INSTALLATION AND OPERATION

Gravity Discharge: For most efficient operating results, install the valve vertically, close to the vessel containing the liquid to be decanted. The size of the inlet should not be smaller than the inlet to the valve. Also mount a full bore valve, equal in bore to the outlet connection on the outlet flange. Any piping downstream of the valve must be short and as straight as possible.

Fit the side run off branch with a full bore valve if it is to be used to run off the lighter liquid from the storage vessel. If not blank it off.

Valve Operation:

1. Commissioning:

a. *Ballasting the float.* The float is ballasted by adding water via the hexagon headed screw in the top of the float to give the float positive buoyancy in the heavier liquid and negative buoyancy in the interface or lighter liquid, as required.
b. *Assembly and initial check.* Place the float in the body on the seat. Locate the guide over the float valve seat. Place the cover in position. The vent, Equilibrium, Inlet and Outlet Valves as well as the side run off branch, if fitted, should be closed.

2. Start up:

a. The Inlet valve (1) is fully opened and the air in the body is released through the vent valve (2).
b. The Equilibrium valve (3) is momentarily opened and then closed, to equalise the pressure on both sides of the float, allowing it to rise in the heavier liquid.
c. The Outlet valve (4) is then opened to permit discharge of the heavier liquid.
d. As soon as the lighter liquid enters the valve body, the Float (5) will sink and stop the further discharge.
e. After further accumulation of the heavier phase in the vessel, the start up procedure is repeated, after first shutting off all the valves.

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CAPACITY

The nominal capacity of all models is referred to a common and arbitrary head of 25-feet or 7.5 metres. This is not, however, a maximum head but merely a reference point for flow capacity design and testing.

Capacity of each model is stated as nominal for the following reasons:

1. Capacity at constant head will be influenced by the temperature, viscosity and specific gravity of the liquids involved.
2. Capacity is also influenced by the degree of ballasting of the float. Normally, the float is at the top of the body when unballasted in water and, therefore, there is minimum restriction to flow through the valve body. At the other extreme, when the float is ballasted to be just buoyant in cold water, it floats at a lower level and having little positive buoyancy is drawn further down the valve body by the velocity effect of the water passing through the valve.

In practical terms, the following guidelines should be observed in deciding which capacity valve to select:

TEMPERATURE

At atmospheric pressure (up to 50-feet 15-metres head of water). Up to 800C and 50-feet head – Normal capacity can be taken. From 800C to 950C and 50-feet head – Reduce nominal capacity by 25%.

At pressures in excess of 50-feet head/15-metres of water. Here the problem is greater and depends upon the temperature and pressure involved and whether the heavy liquid is being discharged to atmosphere or into a closed system.

Since every case must be calculated individually, please refer such applications to the factory.

VISCOSITY

The main point in obtaining the viscosity is to ensure that there will not be excessive “drag” on the float. In general, the essential information required is viscosity at operating temperature and atmospheric temperature. This is particularly important if the liquid becomes solid at atmospheric temperatures.

Viscosities up to 50 c/s at operating temperature have little or no effect upon capacity. From 50 to 100 c/s, capacity should be reduced by 25%.

Any applications over 100 c/s viscosity should be referred to the factory with the fullest possible details of liquids involved, their characteristics, viscosity curve and, particularly, whether suspended solids are present.

SPECIFIC GRAVITY

Most models are designed to have high velocities across the valve seat to ensure self cleaning and the flow is highly turbulent. For turbulent flow conditions, the flow rate varies as:

$$\frac{1}{\text{Specific Gravity}}$$

Thus, as the specific gravity **increases** the flow rate will **decrease.**

Very roughly, the flow rate will change by approximately 50% of the percentage change in specific gravity of one liquid referred to water at a specific gravity = 1.

Example:

If the “heavy” liquid has a specific gravity = 0.8, flow rate **increases** by 10%.

If the “heavy” liquid has a specific gravity = 1.20, flow rate **decreases** by 10%.

VARIATION IN FLOW WITH HEAD

Broadly, flow through the valve can be regarded as similar to turbulent flow in a similar size pipe and the flow rate is directly proportional to the square root of the head applied.

There are, however, limiting factors: the size of the valve body and connections; the size of the valve seat and allowable pressure drop. Each model has been designed to take account of these factors and should never be assumed to have a greater capacity than nominal. The correct selection, in unusual cases, must be done from fairly complex flow test data sheets, but the following guidelines should be useful.

All valves can be sized up to their nominal capacity for heads up to 50-feet of water (15M).

FLOW RATE AND CONNECTION SIZES

The preferred combination of connection sizes for each model valve is shown in the following chart:

Model	Nominal Capacity Imp gph	At head ft.	Design pressure psig.	Inlet diameter	Outlet diameter	Side run off diameter	Flange type*
MS/LC	1500	25	150	2-inch	1.5-inch	1.5-inch	ASA
MS/STD	10000	25	150	4-inch	2-inch	2-inch	150RF
SS6	1500	25	50	2-inch	1-inch	1-inch	to
SS8	3000	25	50	3-inch	2-inch	2-inch	Table
SS10	10000	25	50	4-inch	2-inch	2-inch	H

Other Flange Types Available - Call Factory

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In no circumstances can the inlet diameter be reduced below the stated size.

While the outlet diameter and side run off diameter can be reduced if necessary, there is no advantage and it can result in reduced capacity.

Increasing the size of the outlet diameter and side run off diameter is permitted up to 1.5-inch for the valve models MS/LC and SS6 and up to 3-inches for valve models MS/STD and SS10, but no increase in flow will result.

Where smaller inlet connections already exist, the change of pipe size must be made using welding reducers or longer tapers and not by bushing or other means involving sharp changes in diameter.

APPLICATION

The Belfield valve can be used for practically any decanting operations within the limits of its capacity, pressure and temperature limitations.

It should be noted that this is a *decanting valve, and not a separation valve*. It will not be of any value for systems where pre-separation of the phases has not occurred.

Applications may be broadly classified as:

Discharge to atmosphere

This is the most common application involving discharge of the heavier phase to drain or a second vessel under gravity where all vessels in the discharge side are at atmospheric pressure. The lighter phase may be recovered through the side run off of the valve or via some other run off from the main vessel.

FLOAT DETECTION APPLICATION

It is possible to detect if the valve is OPEN or CLOSED remotely if required by ordering the valve with a 'magnetic' proximity device built into the top of the valve. This requires the valve to be modified with a stainless steel bolted top if it's an MS/STD or MS/LC. Stainless bodied valves are manufactured in this style of top as standard.

This device will require 24vdc power by others and can be used in a hazardous area. There is a magnet attached to the top of the float and when it is in the proximity of the sensor a switched signal is generated indicating valve float up/down. This is a cost added to the standard valve.

PUMPING APPLICATIONS

Pumping applications present no real difficulty. It is, however, necessary to work with a great deal more information and in general no recommendation can be made without viewing detailed pipe drawings and flow sheets. However, certain guidelines can be given.

On general pumping circuits and discharge from pressurised vessels, Belfield valves can be used, where first one phase and then the other are pumped or pressurised from a common storage vessel either to, two other vessels or one phase to drain and the second to storage.

The general guidelines for sump pump applications apply and the automation system is the same. There are however, significant differences. For example:

- The pump will govern the flow rate and it may be necessary to fit an orifice plate downstream of the selected valve to reduce the valve capacity to that of the pump. For instance, a pump may have a capacity of 5000 G/H (22.733 M/hr) at 25-feet head. The correct valve is model MS/STD or SS10.

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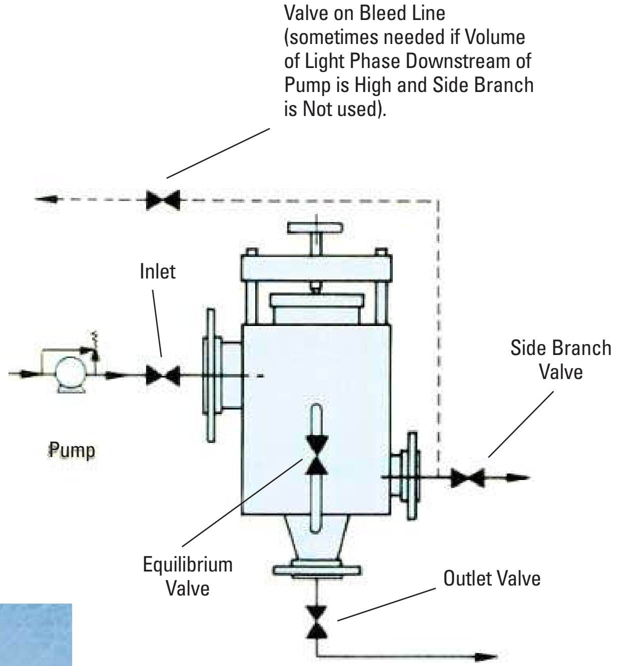
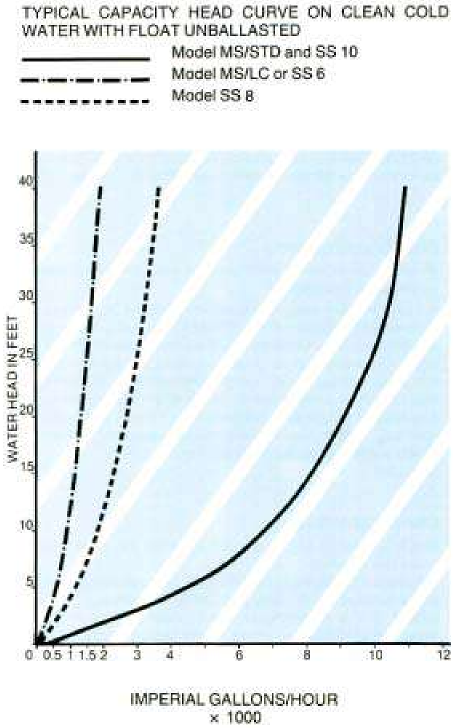


Applications to be avoided

1. Inline separation – **not possible**
2. High viscosity materials, such as tars, heavy lub oils unless heated.
3. Low flow applications where solids are present.
   a. Example: Flows below 300 g/h (1.23M/h) on MS/LC. Flows below 10% design capacity on all other valves. **Note:** Low flows are acceptable on clean liquids.
4. Temperatures where the discharge across the valve involve a sufficient pressure drop to cause "flashing off" of vapour.
5. Crude oils from sources where the wax content is high and agglomeration of wax is a problem.
6. The use of the MS/LC on water drainage from crude oil tanks.
7. Applications where the specific gravities are close and there is a wide temperature variation.
8. Applications involving Hastalloy or other exotic materials.



But, if the heavy phase is running to drain or to storage with no back pressure on the valve, then the valve will try to discharge 10,000 G/H (453M/H) and will close prematurely due to lack of flow at the inlet. A suitable size orifice plate on the outlet, restricting the flow from the valve to about 4500 G/H (19.53 M/H) will prevent problems. **Under no circumstances work with check valves.**

- If it is not possible to install the valve close to the pump and/or if the side run off is used to discharge the lighter phase, then a bleed back into the vessel on the pump suction will be necessary because the pump, line and valve will be full of light phase, unless the pump is allowed to discharge all of the light phase. This is unusual since most pumps have mechanical seals which must not run dry.
- Always remember the valve size must be based on the net head available. That is the difference between the pressure at the pump and the resistance and/or "lift" of the liquid after the valve.
- Finally, always determine the head generated under "no flow conditions" if the pump is centrifugal since this could exceed the safe design pressure of the valve, despite the fact that the head under "flowing conditions" is quite satisfactory.

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SPECIFIC INDUSTRY APPLICATIONS

Environmental Protection

The Belfield valve is increasingly in demand on Environmental Protection Grounds.

Throughout all industries where “Waste Water” is decanted from process or storage vessels to the Effluent Treatment Plant, the Belfield Valve is applied as an environmental protection device to minimise the possibility of accidental discharge of oil, solvents or chemicals into Final Effluent Treatment Plant.

Petroleum Industry

- Drainage of water from crude product tanks and reclaimed oil tanks.

Every refinery also has reclaimed oil tanks for storage of oil recovered from spillage which finds its way to the refinery API separators, where it is skimmed off and pumped to the reclaimed oil tank. Relatively larger proportions of water are also pumped into these tanks or settlers from the oil and the run off rate is high. Numerous valves are used for this duty, with specially enlarged equilibrium valves and connections to avoid blockage. The resulting “water” is often very heavily laden with suspended solids which the valve handles without problem.

- Continuous drainage of rain water from floating roof tank roofs.

Every refinery utilises floating roof tanks for the storage of crude and where large capacity storage is required. This design has two potential problems:

1. Sinking the roof if it fills with rain water and is not drained
2. Discharging the contents of the tank to ground/drains if internal articulated drain joints/hose fail.

To address this problem a Belfield valve may be used on the drain connection at the tank side. The Belfield valve with the optional “swan neck” outlet is designed to allow the valve to stay open whilst water is present whether flow or not. This is affected by allowing the outlet from the valve to be full all the time whilst not being allowed to siphon. The float therefore floats all the time and if a rain event happens, the valve allows the rain to flow from the roof to via the internal drain mechanism and out through the Belfield valve. In the event of a leaking joint or drain hose the Belfield valve will sense the changing gravity and close. This avoids the potential of allowing product to go to drain or contaminate the ground and expensive recovery processes.

It is possible to sense the Belfield float position i.e. is it up or closed via magnetic proximity devices, these can be designed for hazardous areas. This means it would be possible to have a remote alarm in the event the float closed avoiding a roof sinking. This option is only available on the MS/STD. For more information on the float sense system please call the factory.

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Chemical Industry

Below are but a few examples showing the wide range of materials handled:

Frequently, varying two phase systems are placed through the same batch vessel or carry on a series of "washings" within the vessel. In this instance, multiple valves are not necessary, provided temperatures are relatively similar and both phases have similar specific gravity with temperature. It is then possible to find the closest approach of specific gravities that will arise and ballast the float accordingly, then the valve will work even more effectively in these circumstances where the specific gravities diverge. If n doubt, provide the maximum information possible on specific gravities for both phases and temperatures involved for each phase system, or after each "wash", contact the factory for application assistance.

In general, a mixture of gravity discharge and pumping systems will be found with pumping systems predominating.

Typical Two-Phase Systems

- Toluene/Water
- Benzene/Water
- Xylene/Water
- Nitrobenzene/Acid
- Nitrobenzene/70% Sulphuric Acid
- Toluene/Dichloraniline
- Ortho Dichlorobenzene at 80^{o}C
- Organica/10% Sulphuric Acid @ 90^{o}C
- Aniline/Water @ 60^{o}C
- Sodium Sulphite/Organic Nitrile Oil
- Naphtha/Water
- Petroleum Spirit/Water
- Heavy Fuel Oil/Water
- Gas Oil/Water
- Light Distillate/Water
- Aviation Spirit/Water
- Aviation Spirit/Paraffin

Pharmaceutical Industry

This involves drainage of water from storage tanks, for recovering wash material, (Toluene, Xylene etc). and in the final stages of intermediate material or final liquid base products.

A brief list of some materials handled include:

- Epichlorydrdrin/Water
- M.E.K./Water
- MKB/Water
- Toluene/Water
- Benzene/Water
- Many unidentified trade name organic materials/Water

Reclaimed Oil and Heavy Engineering Industries

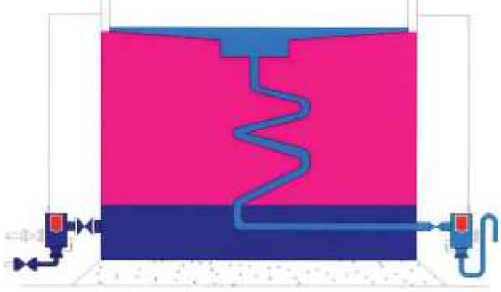
These are based mainly on distillation and there is some water drainage from the recovered product and certainly from the feed material to the plant.

The heavy engineering industry uses large volumes of hydraulic and quench oils which are recovered for reprocessing. These oils all become contaminated with fairly large quantities of water, which is removed after separation in underground sumps or above ground tanks.

Examples of industries involved include:

- Aluminium Industry
- Plastic extrusion industry
- Drop forging industry
- Engine manufacturing

FLOATING ROOF TANK



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