CBI Mechanical Fuel Blender

System Description

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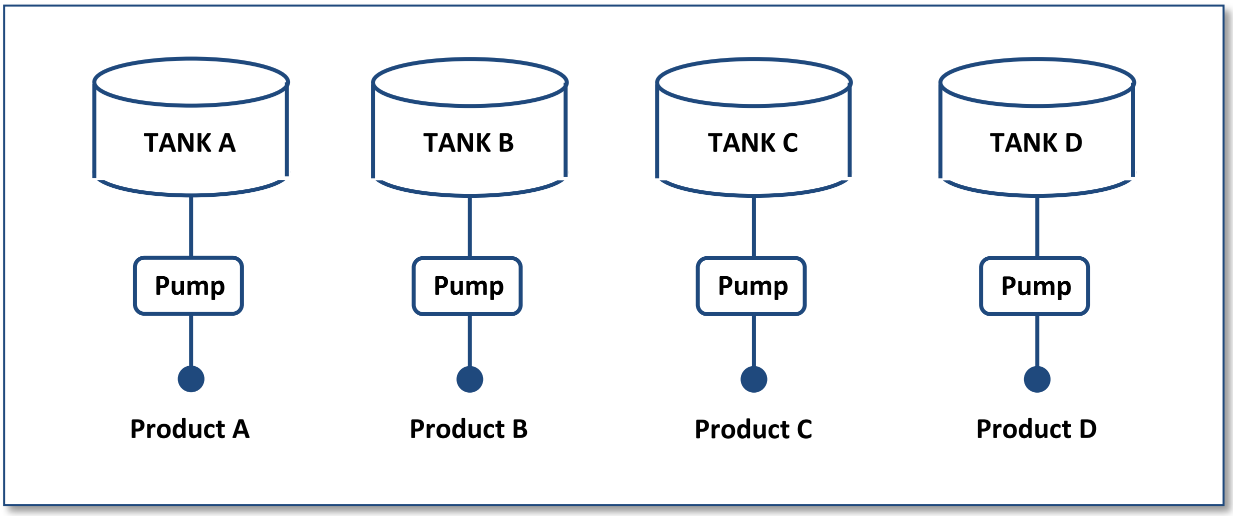
INTRODUCTION

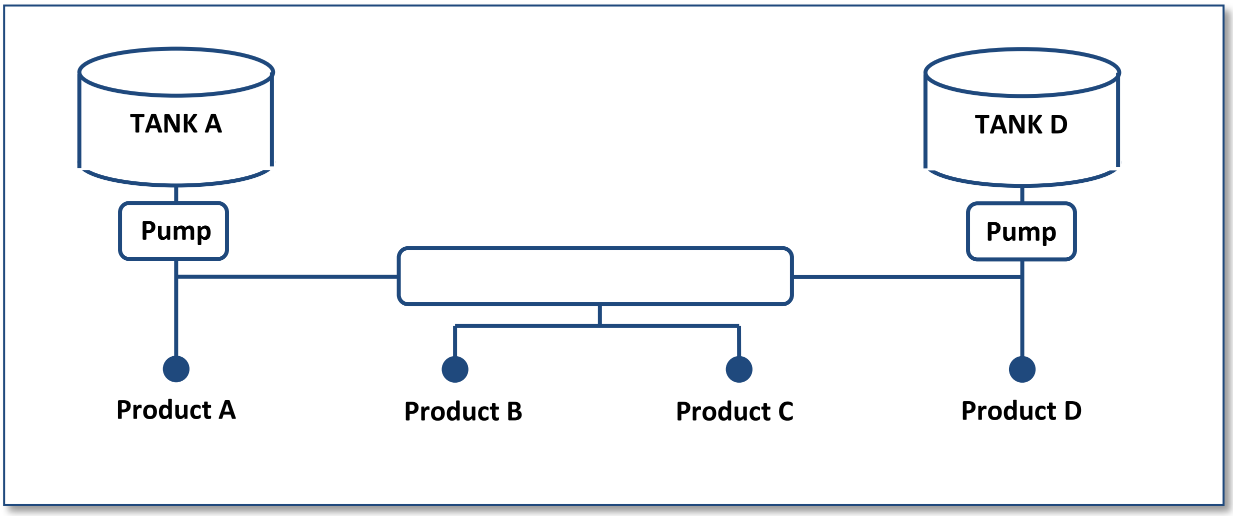
The blending of two or more fluids at a pre-determined ratio in order to produce a finished or semi-finished product is a very common operation in the petroleum and chemical industry. In most cases the measured components are fed, one by one, to a blending tank and as thoroughly as possible intermixed, but when larger volumes are involved this "batch blending" method has become substituted by "in-line" blending. Here the components, in controlled flow corresponding to the ratios, are simultaneously fed to an intermixing device from which the finished blend continuously flows.

In the petroleum industry the blending of a light distillate (gas oil, etc.) with a heavy product (Bunker C, heavy fuel, etc.) in varying proportions, in order to produce heating oils of various grades, is widely used. Mostly this blending is done at the refinery of the larger main terminals, either as batch or as in-line blending and the grades are carried to the distribution terminals for transport in tank trucks, railway tank cars, etc. to the ultimate user. Thus it becomes necessary to equip each distribution terminal with at least one tank for each grade.



Tanks, including pumps and piping, represent large investments. If it was possible to install a blending unit at the distribution terminal only tanks for the base grades would be needed and for each intermediate grade distributed, one tank with piping could be saved.

With an inexpensive blending unit installed, the savings in investment would be very considerable.



The blending units hitherto used are, however, are expensive and complicated to operate, and require indoor installation. For the small or medium-sized distribution terminal they are not suitable, either from an investment or an operation standpoint which is the main reason for today's arrangements at the distribution terminals.

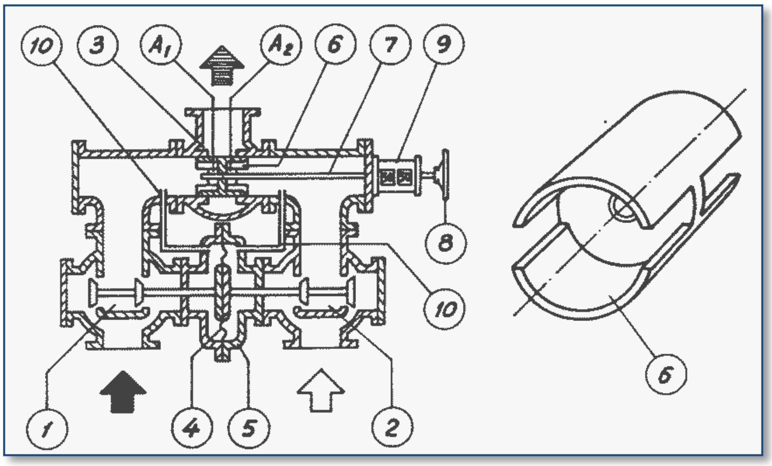
The CBI Mechanical Blending Unit represents an entirely new development:

- It is inexpensive. No auxiliaries, such as electric motors, compressed air, etc. are needed.
- It is easy to operate. Turning a hand wheel, changes the ratio setting which is shown direct in figures on the counter. Once the ratios for different grades are determined and handed to the operator, he has only to turn the hand wheel until the corresponding figures show on the counter.
- It is easy to install. It can either be mounted as shown on figure, page 8, turned upside-down with the inlets pointing upwards, or mounted horizontally. With the connecting pipes properly braced no extra supports are needed - the unit can be mounted as an ordinary valve. No housing is required. In cold climates, or when heavy oils are used, it can be surrounded with a heated and insulated cover. Units installed 70 miles north of the Arctic Circle operate successfully in this way.

With the CBI Mechanical Blender it becomes possible to realize the idea of blending at the distribution terminal.

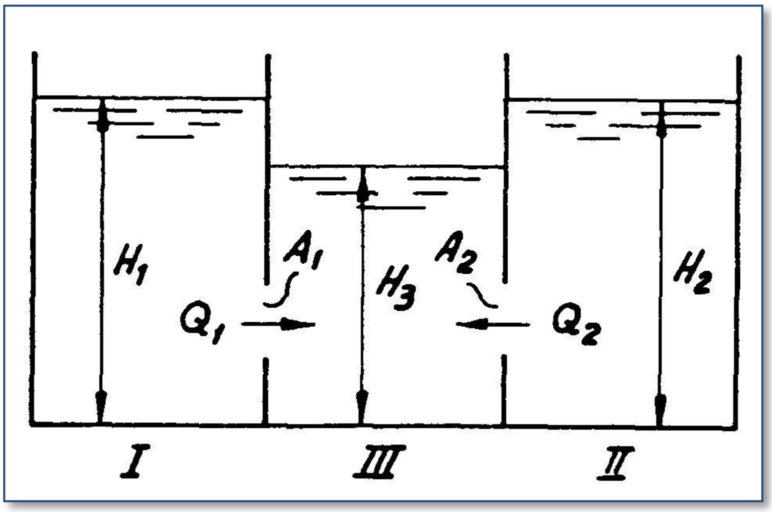
DESIGN AND FUNCTION

The CBI Mechanical Blending Unit consists of two balanced pressure-regulating valves (1) and (2) with inlets for two components and outlets to the blending chamber (3). The valve discs are united with a stem carrying the diaphragm (4), mounted in the housing (5). A horizontal movement of the diaphragm will throttle one valve and simultaneously open up the other. In the blending chamber (3) the slide (6) can be moved horizontally by turning the threaded spindle (7) with the hand wheel (8). The slide (6) has, on both sides of its dividing wall, two openings to the blending chamber (3), and by moving the slide to the left, the opening areas Al will decrease and the areas A_2 increase; the opposite happening when the slide is moved to the right. The spindle (7) is geared to the counter (9), equipped with a pair of figure rollers showing the percentage ratio of the component at the mere side of the unit.



When the slide is in centre position and the areas A_1 and A_2 equal, the counter shows 50/50. If the slide is moved to the left and A_1 is decreased to 25% (and A_2 simultaneously increased to 75%) of the total opening area, the counter will show 25/75. Thus any operator, understanding simple figures, can adjust the unit to desired ratio setting.

From a point on each side and immediately before the opening in the blending chamber two pipes (10) connect with the corresponding sides of the diaphragm housing. An increase in pressure on the left side of the system will cause the diaphragm to move to the right, throttling valve (1) and opening valve (2), which will reduce the pressure on the left side of the system and increase pressure on the right until pressures on both sides are equal. As the connecting pipes (10) are short and the valve's inertia small the regulating acts extremely fast.



Through special dampening devices, not shown, the oscillating is practically eliminated and a sudden change in inlet pressures is regulated in fractions of a second.

The action of the CBI Mechanical Blender Unit can be compared with the action in the vessels shown on the illustration to the right.

The two vessels I and II represent the inlets to the blending chamber of the Mechanical Blending Units, where pressures = H_1 and H_2 exist. Through openings with areas A_1 and A_2 respectively the flow Q_1 and Q_2 enter the vessel III, representing the outlet with pressure = H_3.

The following well-known equations can be set up for the flow:

$$Q_1 = \mu_1 A_1 \cdot \sqrt{2g(H_1 - H_3)} \qquad Q_2 = \mu_2 A_2 \cdot \sqrt{2g(H_2 - H_3)}$$

Where µ1 and µ2 are coefficients, depending upon shape of the openings A_1 and A_2. As these are almost identical, for all practical purposes it can be considered that $\mu_1 = \mu_2 = \mu$.

Further, the pressure regulating valves (1) and (2) tend, as described above, to equalize the inlet pressures and consequently $H_2 = H_1$.

By putting the two equations above as a ratio, inserted µ for μ_1 and μ_2 and H_1 for H_2 we obtain:

$$\frac{Q_1}{Q_2} = \frac{\mu \cdot A_1 \cdot \sqrt{2g(H_1 - H_3)}}{\mu \cdot A_2 \cdot \sqrt{2g(H_1 - H_3)}}$$ **Simplified to:** $$\frac{Q_1}{Q_2} = \frac{A_1}{A_2}$$

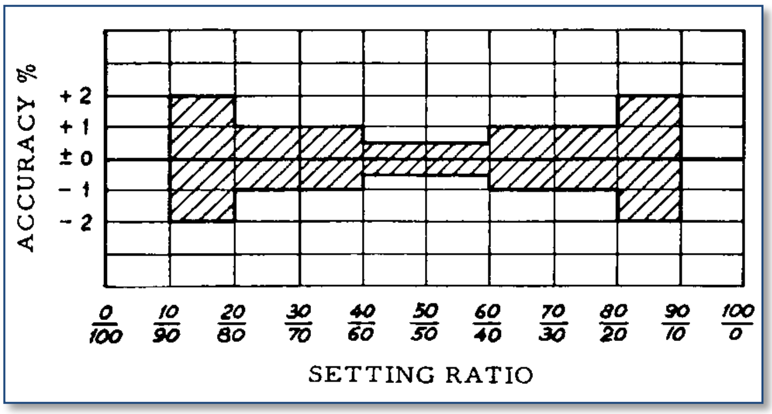
Which means that the blending ratio is determined only by the ratio of the slide opening areas, i.e. the position of the slide.

INFLUENCE OF VISCOSITY

Flow through the slide openings can be compared with flow through a metering orifice, where viscosity has negligible influence on the pressure drop. It is true, however, that the pressure drop from the sensing points-inlets of the pipes (10) to the outlets in the blending chamber will vary with varying viscosities but is, owing to the short distances involved of no practical importance. Numerous tests in the field have proved this fact.

ACCURACY

At 50 to 100% of the recommended capacity given in the drawing the accuracy at ratios from 40/60 to 60/40 is better than ± 0.5%. At 20/80 to 80/20 it may drop to ± 1%; and at 10/90 to 90/10 it may decrease to ± 2% of the ratio setting.



Below 10/90 and 90/10 respectively the accuracy varies considerably and it is not recommended to go beyond these values. Accuracy can be improved by adjusting the inlet pressures, outside the blending unit, in such a way that the diaphragm will stay in centre position (observed on an indicator furnished on request with the unit).

HOMOGENEITY

The areas A_1 and A_2 represent a considerable restriction in flow area and will, therefore, create a strong turbulence with corresponding pressure drop. The turbulence, in connection with the shape of the blending chamber, gives a very thorough intermixing of the components and the blend becomes homogenous.

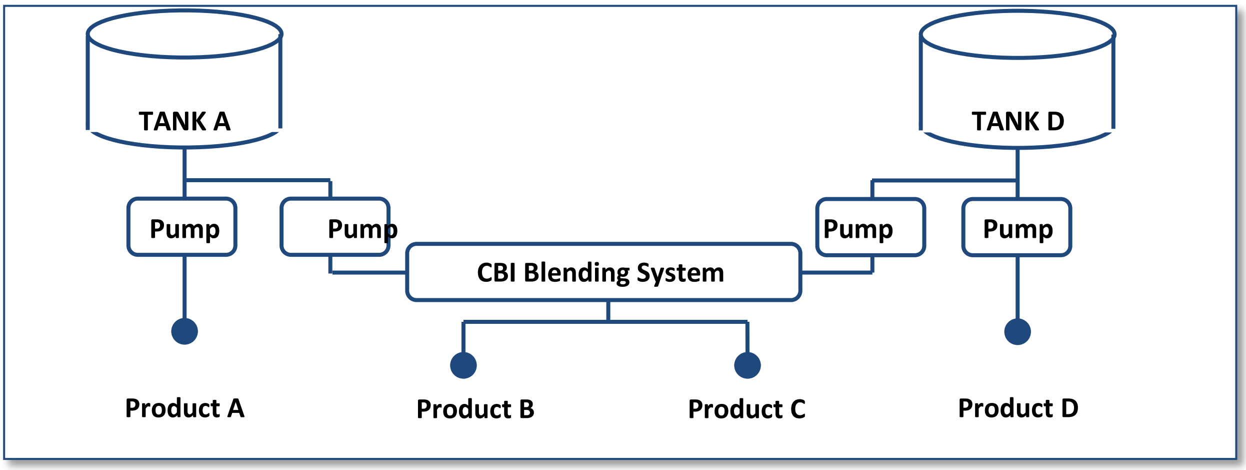
To create the required turbulence it is necessary that the flow through the openings has a certain minimum velocity. If the flow rate is decreased below 30% of the recommended, turbulence might not be strong enough to give a reliable homogeneity.

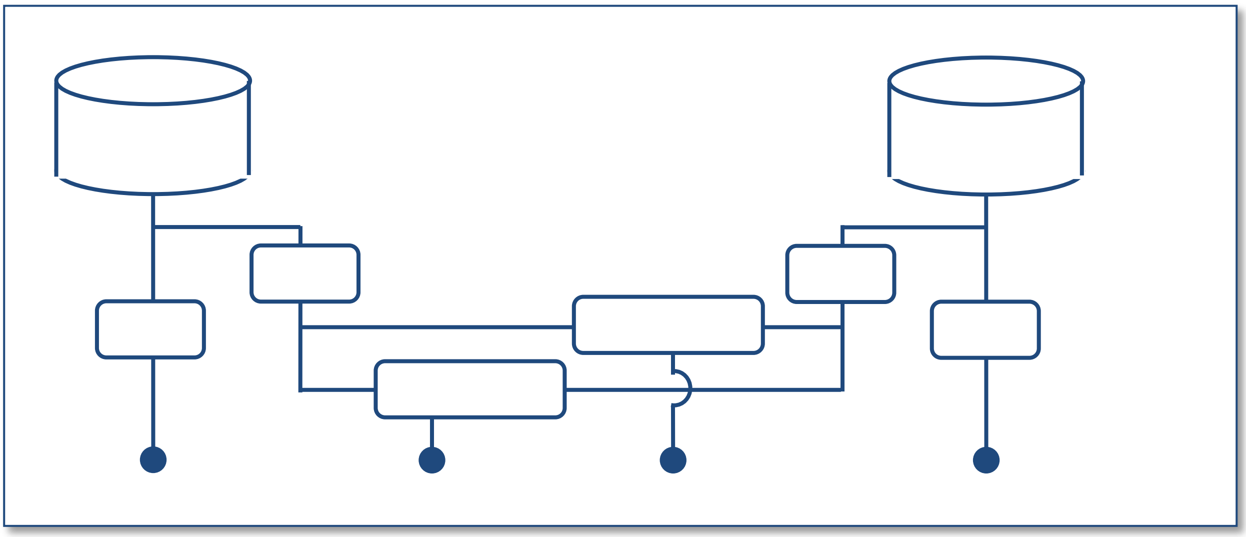
INSTALLATION

The CBI Mechanical Blending Unit can be installed in several ways. In many cases the two pumps, which have to be rated to take both direct loading of the base grade and feed to the blending unit, can be split up in four smaller units and handled by separate pumps as shown below.

Should it be necessary to load two intermediate grades at the same time two blending units can be installed. In this case each unit can be left un-altered after being properly adjusted to the correct setting.

For extremely varying loading capacities - loading tank trucks and bunkering ships from the same terminal - two units of different capacity can be installed and also run parallel to meet heavy capacity demands.

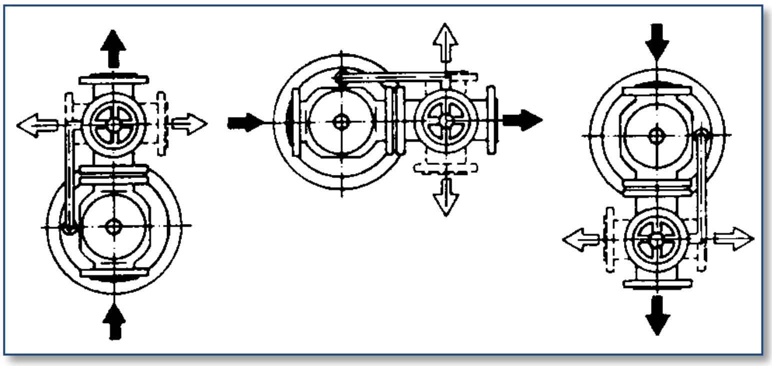




The various possibilities are practically unlimited and the flexibility of a small or medium-sized terminal can be greatly increased by installing the CBI Mechanical Blending Unit.

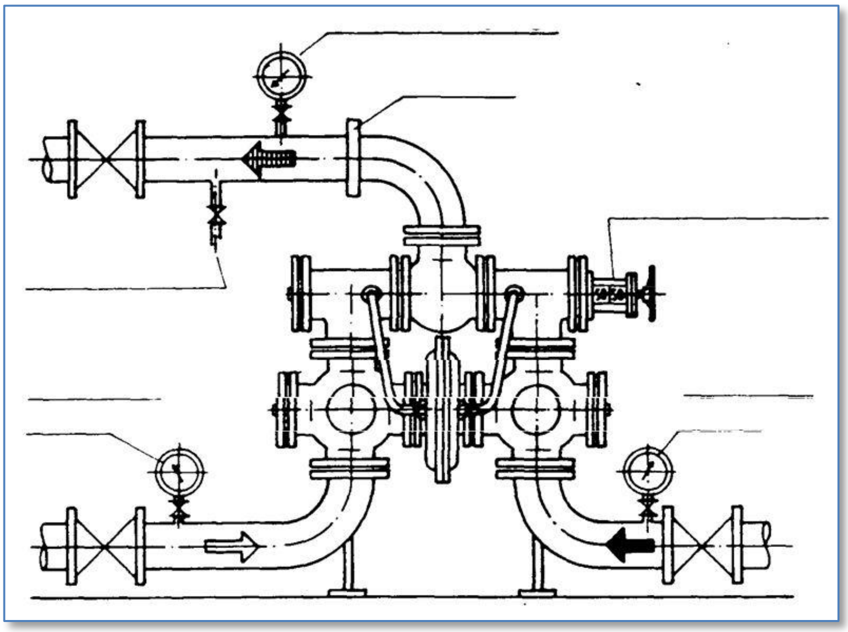
MOUNTING

The blending unit can be mounted in several positions.



It is important that the centre line through the regulating valves always is horizontal. The smaller units, up to 4", can be mounted without supports direct in the pipelines, while the larger ones preferably are supported by brackets placed so that full access to the flanges is secured and further so that no stresses are placed on the flanges of the blending unit. Under no circumstances should the unit be used as a pipe support.

The inlets of the blending unit are equipped with check valves to stop flow from one component pipe with higher pressure to the other component pipe, when the flow in the pipe from the blending unit is shut off.



The figure on to the right shows a typical installation of the CBI Mechanical Blending Unit. The ratio indicator is shown on the right side of the unit; if so desired and ordered it can be placed on the left side. It is advisable to weld on connections for pressure gauges and sample cocks as shown.

If placed outdoors in cold areas or when very heavy products are used for blending, it might be necessary to insulate and heat the unit, and the most convenient way is to make sheet housing with insulation on the inside and a steam coil or electrical heater to keep the air temperature inside the housing at a proper level.

STARTING UP

The procedure in starting up a newly installed blending unit is very simple and is described in detail in the manual sent with every unit. At normal flow rates the pressure drop over the blending unit is about 10-20 psi (depending on blending ratio, the viscosity of the components etc.).

The pump pressure must, therefore, be adequate to overcome this and, furthermore, the difference in pressure between the two components should not be too large. Before ordering a Mechanical Blending Unit it is advisable to examine pump and other data in order to eliminate changes and adjustments at a later date.

ADJUSTMENT

The manufacturers setting of the Mechanical Blending Unit is the best accuracy at a blending ratio of 50:50. During the actual blending operation, however, a ratio of approximately 80:20 or 20:80 is more common. It can, therefore, be necessary to adjust to fit the ratio mostly used.

As soon as the viscosity of the components and of the blend is established the adjustment can easily be made within a few minutes with the help of a normal screw driver.

If, as an example, the blending unit is set at a ratio of 80:20, but the blend received is equivalent to a ratio of 78:22 the adjustment is made as follows:

1. Remove the four screws securing the end cap of the ratio indicator.
2. Pull this cap slowly toward the hand wheel until the first counter wheel appears.
   The ratio setting device is attached to the inside of the cap.
3. Turn this wheel until the setting of the counter is correct - in this example 78:22.
4. Slowly push the setting device back into the housing. Be careful during the last 1/4" to 3/8" of the movement as the gear wheels driving the device engage. It may be necessary to move the hand wheel a few degrees back and forth in order to achieve this engagement. Do not force the device back in place.
5. Replace and tighten the four screws.

The ratio indicator is now adjusted to the true blending ratio. It is recommended to test the blend a few times in order to control the adjustment. If meters are installed this can easily be done. If not, the viscosity of the two components and the blend should be established and a blending chart used to find the corresponding ratio.

In this connection we want to emphasize that the blending is volumetric and the ± 2% accuracy is by volume. In order to find the corresponding viscosity accuracy range the blending chart has to be consulted.

DIMENSIONS

The flow rate refers to finished blend at maximum working pressure and ideal conditions.

The standard unit is delivered with flanges according to the Swedish Standard SMS 342 (DIN 2532) for maximum pressure 10 kp/cm2 (142 psi). Companion flanges can be ordered with the unit. Special check valves are fitted in the inlets.

The standard unit has a body of cast iron, valve trim of bronze and shafts of stainless steel. The diaphragm and gaskets are suitable for temperatures up to 80°C (176°F). Other material on request

An electric gear motor and selsyn for remote setting and indicating of the blending ratio can be fitted.

Connections SMS 342	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	Weight kg	Total flow litres/min
80	494	247	140	160	430	580	340	315	210	800-1000
150	760	380	215	240	660	875	490	405	550	3600-5000
200	828	414	265	330	760	1020	490	430	880	6000-8000