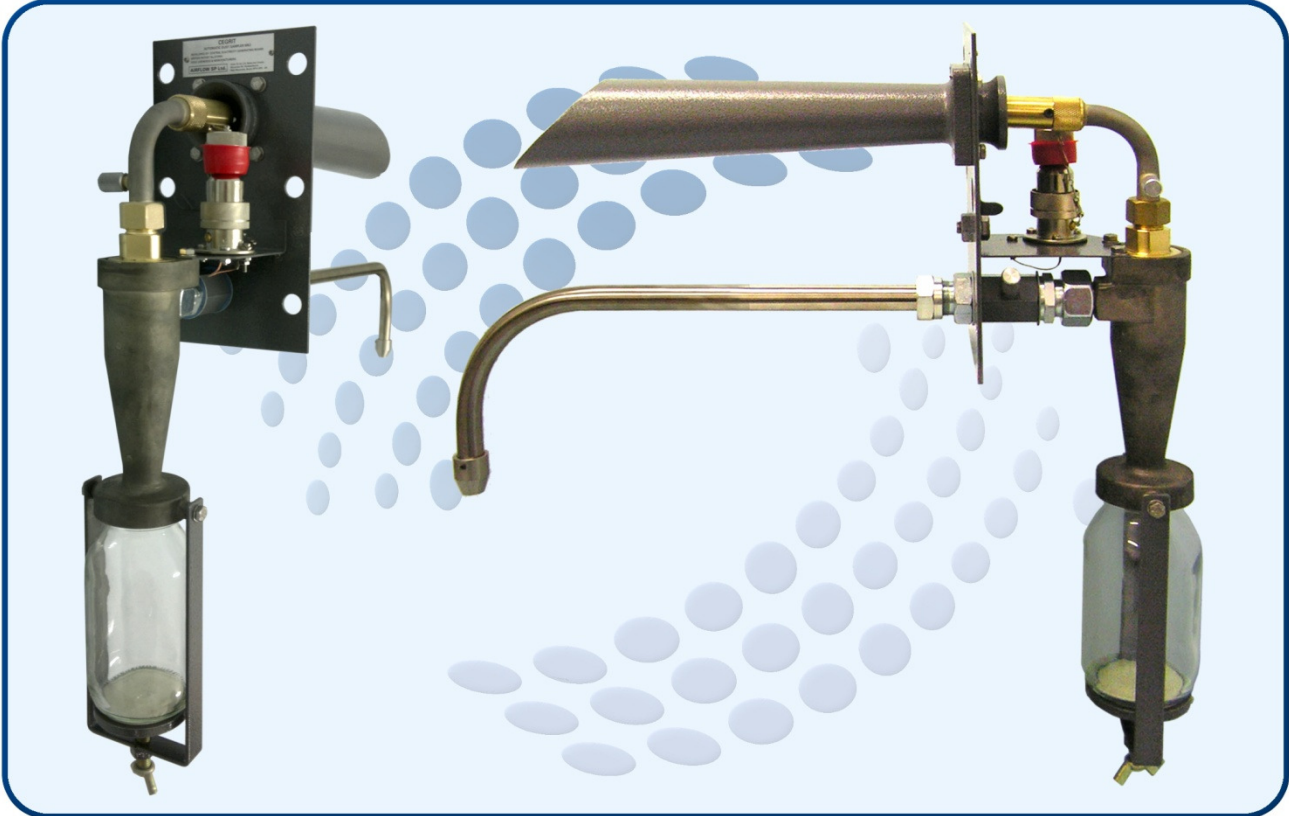


The Original CEGRIT - Mk II

Automatic Isokinetic Particulate Sampler

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- Visual means of checking sample condition while in operation
- Extremely reliable – no moving parts
- Robust construction
- Easy to install
- Very low maintenance
- Self-regulating to within 12% of isokinetic conditions, from zero to maximum boiler load
- Sample capture efficiency rate – typically 99%
- Original concept developed by the C.E.G.B in 1950's
- Proven technology over 50 years in service
- NISIL coated cyclone for longer life of system
- NEW – Positive flue pressure purge pipe available (Not shown on illustration)
- NEW – Larger isokinetic nozzles for low flue velocities (by special order)

1. History of CEGRIT

The original CEGRIT, Automatic Isokinetic Particulate Sampler, was developed by the South Eastern Division of the C.E.G.B (Central Electric Generating Board) in March 1959 to extract fly-ash and dust particles from boiler gas mixtures. Sensing Precision Limited exclusively continues to manufacture this unique system. More than 50 years later and the 'CEGRIT Mk II' is still one of the preferred methods for collecting particulate samples because the gas samples are extracted isokinetically, even when stack gas velocity fluctuations occur during the extraction period.

2. Why Pick CEGRIT?

With no moving parts, CEGRIT was revolutionary in its concept. It is the most cost effective and efficient method of Automatic Isokinetic Sampling of air borne gas particulates down to as low as 5 μM . The system has a general capture efficiency of greater than 99% and maintains an efficiency of 95% even when measuring as low as 5 μM , irrespective of boiler load conditions. The system requires no form of power (unless a heater jacket is required – see section 3) to operate continuously and apart from periodic emptying or replacing of the glass sample container the system requires very little maintenance.

3. Application

The CEGRIT is applicable wherever particulate samples are required to be extracted from flowing gases. It will provide a substantially isokinetic sample in any situation where there is a suction greater than 250 Pascal's (1" W.G).

In pulverised fuel boilers it is used for Carbon determination in fly ash, enabling a valuable visual check to be made on combustion efficiency and fly ash quality. In large oil fired boilers, where additives are used to control acidity, continuous sampling and analysis of the flue particulates allows an operator to achieve maximum economy and optimum effectiveness.

A more general application would be on all types of boiler in relation to the Clean Air Act in which guidelines have been clearly set in national and international standards for the accurate measurement of particulates emitted into the atmosphere. This act specifies quantitative values for the permissible levels of dust from boiler chimneys and flue stacks which CEGRIT is designed to extract and sample.

4. Suitability and cost

The relatively high costs involved in running and maintaining specialised equipment, required to comply with the latest national and international standards for particulate sampling, can be extremely prohibitive.

The CEGRIT is a low cost system ideal for isokinetic sampling air borne particulate between 250 μm and 5 μm and benefits from a cyclone capture efficiency percentage better than 99%. Once the CEGRIT is installed, operators should be able to satisfy any inspecting authorities that they have a completely reliable and efficient means of continuously checking the particulate levels in their flue gases. This inexpensive system would be an ideal addition to any boiler plant as a measurement device allowing insurance and against excessive particulate level emissions.

5. Principle of Operation

The device consists of a NISIL coated Gunmetal Cyclone through which a sample of flue gas is continuously drawn by an ejector device operated by the suction (negative static pressure) within the flue system. A detachable glass container, secured to the bottom of the cyclone, collects the particulate which has been separated out from the gas. The particulate builds up in layers so that it is quite easy for the boiler operator not only to observe the rate of mass particulate accumulated but also to take note of any perceptible change in colour or quality of the fly ash which might, for instance, indicate the carry-over of un-burnt carbon.

The great ingenuity of the device lies in the fact that not only does it operate continuously without any moving parts but once it has been set for isokinetic sampling of dust, from a selected point in the gas stream, it continues to operate isokinetically (that is with a suction velocity at the entrance of the nozzle equal to the flue gas velocity surrounding the nozzle). This continues irrespective of fluctuations in the main gas flow resulting from adjustments of flue suction.

6. Description

All the components of the system are mounted on a 3mm thick epoxy powder coated mild steel base plate, from which the device is secured to the flue ducting. The cast iron ejector trumpet can be rotated to any of four positions to suit the direction of flue gas flow. The probe & nozzle tube assembly can also be rotated to suit the flue gas direction and is locked with an olive and locking nut.

The ejector nozzle, located centrally in the venturi throat of the cast trumpet, is adjustable brass to facilitate setting of the sample rate to isokinetic conditions.

The cyclone assembly should be insulated by an electrical heater jacket (available from Sensing Precision Limited) to eliminate condensation while sampling. This inhibits the particulates from sticking to the cyclone and forming a mass, clogging the cyclone. The heater jackets available are rated at 110Vac or 240Vac and an inline plug and socket is located on the cyclone bracket for connecting to a suitable electrical supply (please advise voltage required when ordering system). The Cyclone assembly can be easily removed to facilitate periodic cleaning or replacement as and when necessary. Two manometer tapping points are provided, one at the inlet and one at the outlet of the cyclone for initial set-up of installation.

The glass sampling vessel is secured in position below the cyclone by a stirrup clamp assembly with winged screw for adjustment. The glass jar can easily be removed by loosening the winged screw for closer analysis of its content.

Sampling nozzles and probe tubes are manufactured from stainless steel. The nozzles are available in four standard sizes: 9.52mm (3/8"), 12.7mm (1/2"), 15.88mm (5/8") and 19.05mm (3/4"). Probe tube are also available in varying length, up to a maximum length of 3 metres, these components must be sized to best suit to the flue gas criteria at the point of sample.

7. Nozzle

The nozzle size to be used depends on the gas velocity and density. A size should be chosen that will achieve an equivalent flow-rate through the cyclone of between 6.8 and 10.2m³/hr (4.0 to 6.0 cfm) at the boilers maximum calorific rating for isokinetic sampling. This ensures a high cyclone particulate capture efficiency percentage rate (typically better than 99% of particulate captured above 5 µM). A nozzle diameter of 15.88mm (5/8") will generally be found suitable.

The attached chart (fig 1.1) shows cyclone pressure drop related to gas velocity head (Pitot differential pressure), for various nozzle sizes. As an example if coal, having a very high fly ash content, is being burned the glass container may fill too quickly if a larger nozzle is used.

For convenience a smaller nozzle may be chosen, to reduce the sample rate, without significant loss in cyclone collection efficiency. The lower sample rate will reduce the frequency to which the glass container needs emptying and will increase the useful life of the cyclone assembly as the erosion rate of this part will also be reduced.

8. Installation

The CEGRIT can be used for up, down or horizontal gas flows, as both the cast iron ejector-tube and 'sampling nozzle probe assembly' can be rotated in any of four 90° angular positions. The materials used in the systems construction, allow it to sample flue gas temperatures up to a maximum of approximately 540°C (1000°F), typically corresponding to air heater inlet temperature, but the CEGRIT may also be located at the heater outlet.

A location should be chosen where the distribution of gas velocity and media particulate is likely to give the most laminar and therefore the most favourable results.

Easy access to the CEGRIT must be provided, particularly if the sample is to be frequently inspected. If located in an area open to atmospheric conditions, protection must be provided against rain and extreme cold.

9. Operation

As the CEGRIT will operate during the lighting-up and initial loading stages, the sample collected during this time should be discarded if it is not to be included in the sample for the whole shift. When the sampling flow rate has been correctly set, it will then self-regulate to within 12% of isokinetic conditions from zero to maximum boiler load with no significant effect upon the accuracy of the sample.

The sampling efficiency of the CEGRIT cyclone is extremely high: for example, with an isokinetic nozzle Diameter of 15.88 (5/8") in media with a mean stack gas velocity between 6 and 14 m/s (1181 and 2763 fpm) the particle arrestment efficiency of fine pulverised fuel dust is better than 99%.

10. Cyclone Agitator (Optional)

If the particulates being sampled are of a clogging nature we are able to offer an agitator which is positioned on the central axis of the cyclone tapered body. This agitator rotates freely about the exit of the cyclone stopping the sampled particulate from clogging in the body of the cyclone.

11. Nozzle Sizing for Best Cyclone Sample Efficiency

To enable the CEGRIT system to extract a representative sample of the 'Mass Rate of Particulate Flow' (MRPF) from any chimney, flue or stack, it is most important to ensure the isokinetic sampling nozzle being used is of the optimum size for the 'Sample Position Gas Velocity' (SPGV).

To calculate which nozzle size will best suit your application you must first identify the SPGV, in meters per second, using a pitot static pressure tube. This must be done as close as possible to the actual sampling point. Once this has been identified simply use the equations below to find the optimum size nozzle:

Maximum Usable Nozzle Diameter (mm) =

$$\sqrt{\frac{40.8}{0.0113 \times SPGV}}$$

Minimum usable Nozzle Diameter (mm) =

$$\sqrt{\frac{27.2}{0.0113 \times SPGV}}$$

Example: The SPGV has been calculated to be 16 m/s.

Maximum Usable Nozzle Diameter (mm) =

$$\sqrt{\frac{40.8}{0.0113 \times 16m/s}} = 15.022$$

Minimum Usable Nozzle Diameter (mm) =

$$\sqrt{\frac{27.2}{0.0113 \times 15m/s}} = 12.265$$

Therefore the smaller 12.7mm (1/2") diameter nozzle should be used. However, if the mass particulate flow rate is relatively low the 15.88mm (5/8") diameter nozzle can be adopted to increase the sample rate without a significant drop in cyclone sample capture efficiency rate.

12. Setting Cyclone Differential Pressure Drop

To set the CEGRIT cyclone to isokinetic conditions the following information will be required:

- Pitot differential pressure measurement at nozzle sampling position in Pascals.
- Nozzle size used.
- Gas temperature at nozzle position (in °C)
- Cyclone differential pressure measurement

Ensure the entire system and the joint between the flue duct wall and the mounting flanges are air tight. Switch on the CEGRIT heater jacket (if fitted) and allow the cyclone to warm up. Connect a manometer (a 2 kPa vertical fluid manometer is ideal for this purpose) across the two cyclone manometer tapping points (fig 1.2) using a suitable 5mm bore flexible tube (Silicone, PTFE, Viton etc.). This will allow you to take the cyclone differential pressure reading.

Insert a pitot static pressure tube, connected to a suitable measuring device, through the sight hole provided on the mounting plate (by moving the spy cover to gain access). With the boiler operating at a steady load (say between 80% and 100% M.C.R) take a pitot reading as close as possible to the sampling point without allowing the reading to be affected.

Take a reading from both sets of equipment. Using the CEGRIT setting chart (fig 1.1) you need to compare your two results in reference to the correct sized nozzle. Please note that the cyclone differential pressure may vary depending on the flue gas temperature. 150°C is preferable.

Adjustment of the cyclone pressure differential is made by screwing the brass ejector nozzle into or away from the cast iron trumpet venturi mouth (see fig 1.2). When the differential pressure instrument adopted reads the same pressure as plotted on the chart, the CEGRIT will collect samples within 12% of isokinetic conditions from zero to maximum boiler load.

Example: You are using a Ø12.7 nozzle and the flue gas is at 150°C. First take the reading from your pitot. In this example it reads 150Pa. Referring to the CEGRIT setting chart find 150 Pa on the 'X' axis, follow this line up until you meet the line detailed as Ø12.7 and then follow this line across to the 'Y' axis to find the desired cyclone differential pressure. This is the pressure you are looking to obtain from the manometer connected to the CEGRIT, in this case approximately 750Pa. If this is not the case adjust the brass nozzle until the desired cyclone differential pressure is met. If the flue gas temperature was at 300°C the desired cyclone differential pressure would be 900Pa.

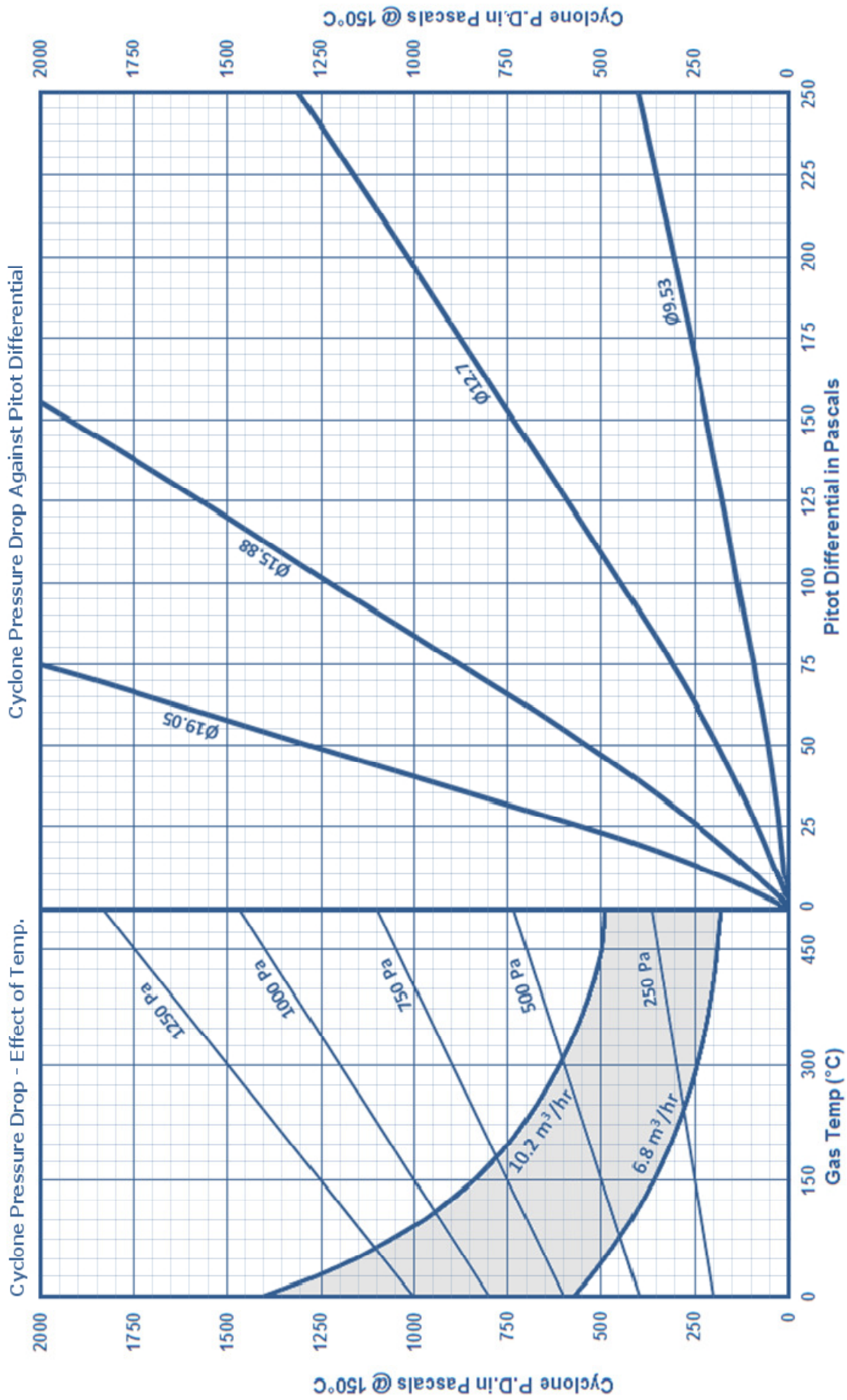


Fig 1.1

CEGRIT - Automatic Isokinetic Particulate Sampler

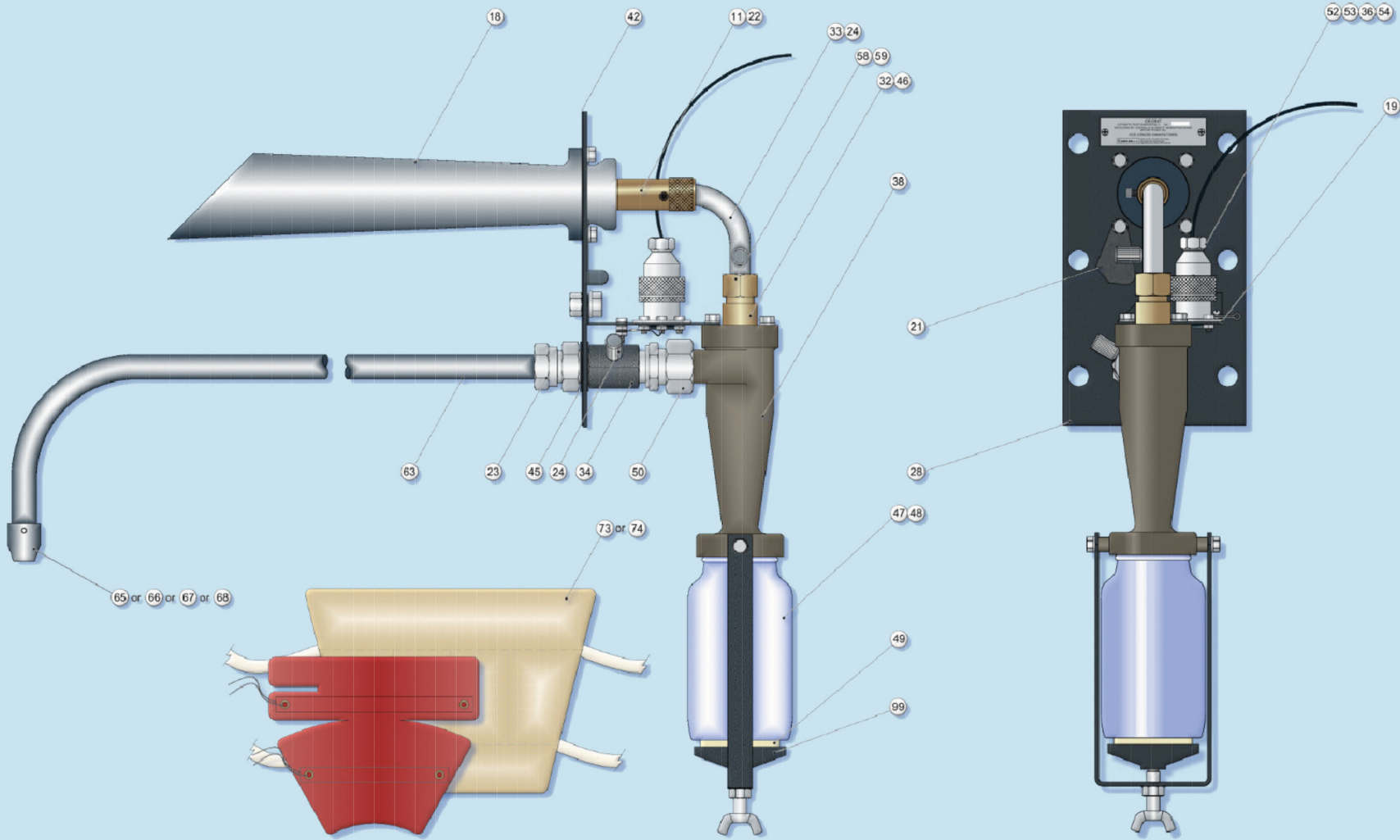


Fig 1.2