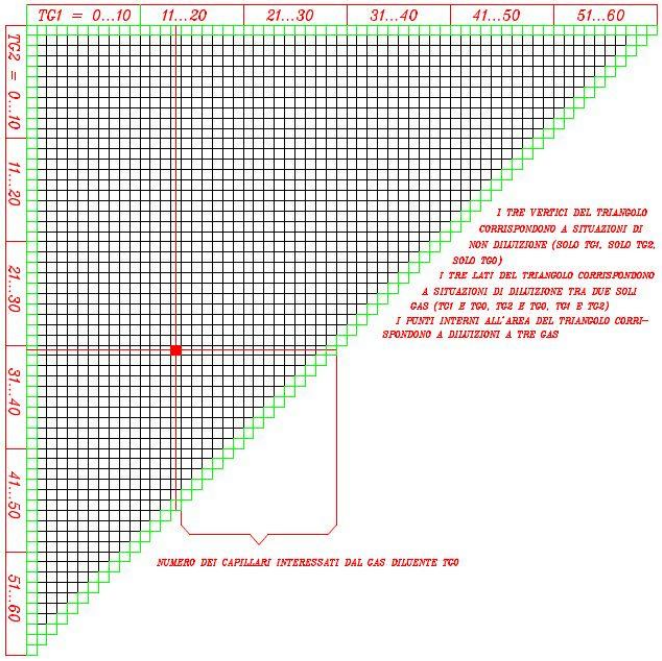
TO DILUTE TWO ACTIVE COMPONENTS IN A DILUTING GAS: BETACAP60-3G

The diluter uses 60 equal capillaries and a solenoid valves network that directs to each capillary the first gas to be diluted, the second or the diluting gas.

In addition to the linearity tests (one-component) is then possible to perform tests of cross interference, in which the concentrations of the gas to be measured and the interfering component can vary both between zero and 100% of the value entered in the diluter.

Another important application of this diluter regard to the testing of pilot plants: a typical example is evidence of gas combustion devices, which require for testing different combinations of flow of two fuels and air. Using multiple capillaries can be obtained in output flow rates in the order of 6000 L / h with inlets to 2 Bar

The main advantage of using the capillaries is in the extreme stability of performance: the fouling of the capillaries is the only possible cause of drift, but with gas from a cylinder (dry and clean), combined with the thrust of the air filtration of the gas inlet, drifts in the short and medium term are not detectable.



This results in:

- User Confidence in the quality of their work
- Long intervals between successive calibrations allowed metrology (high availability and low cost of ownership).

The instrument actually contains two diluting units that operate in a coordinated way without the user must deal with this. The space of the dilutions is divided into 60 x 60 intervals: the oblique line of the lower boundary corresponds to the various mixtures of the two active gases without the presence of the diluting gas.

Two solenoid distribute the three incoming gas to the two dilution units, according to need: this function is automatically activated when it is required one of the components in a concentration greater than 50% of the content in the cylinder. Four pressure sensors are on the reference variable for the three differential pressure controllers (inlet - outlet) that control the three incoming gas.

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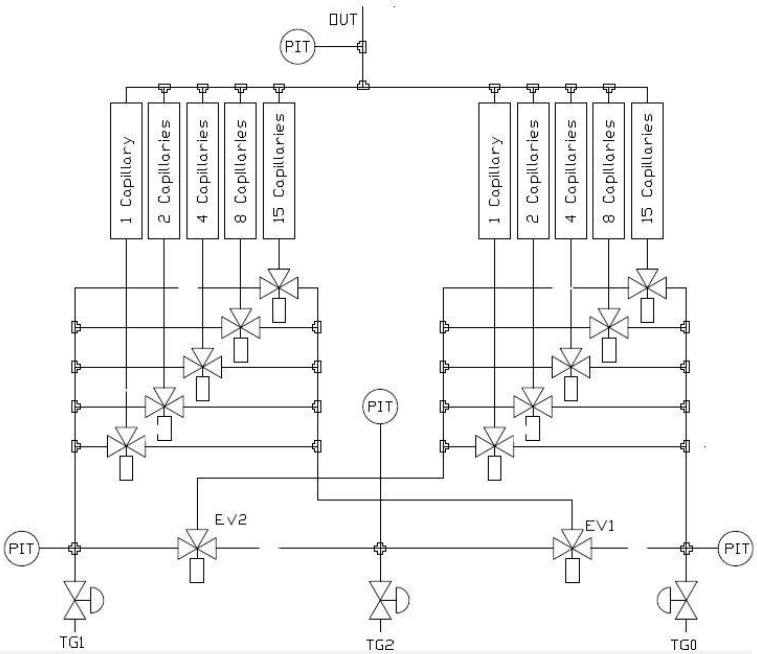
The aim is to ensure the balance of pressures, and therefore for the calibration of the 4 sensors do not require a pressure reference traceable: it is useful for the operator that the indicated values be nearly real, but it is only necessary that these are aligned between them. The reference for the zero calibration is the atmospheric pressure, while for the reference sensitivity the sole requirement is that the same value of pressure is applied to all four sensors during calibration ; just close all inlets and supply the pressure to the outlet with a stable pressure.
The construction of the diluter BetaCAP60-2G respects the rules already applied for the consolidated predecessor BetaCAP30: all the way gas and pneumatic components are housed inside or on the surface of a manifold made by PVDF (also available in stainless steel). Only routes of entry / exit are made with pipes and compression fittings. The result is a compact, very rugged, with reduced dead volumes, and isothermal with very little chance of leaks.
The materials in contact with the gas to be treated (PVDF, PTFE, PEEK, AISI 316L, Glass, Kalrez, Viton) are resistant to most of the gaseous components in the usual concentrations (in option, we can replace the Viton with Kalrez and / or PVDF material with AISI 316L).
The availability of two virtually identical dilutors, and the progression 2n of the capillaries number for each group, has also allowed the application of an interesting procedure for the self-verification of the the diluter quality, determining the errors (minimum differences flow caused by uncertainties in the process of selection of the capillaries) and for the automatic compensation of the same. In order not to burden the firmware, program verification and automatic compensation of errors is available as a software package for Windows PCs.
The proof is obtained as a sequence of steps that can be flow measures (meter in the range 1a ... 15a) or concentration measurements (analyzer in the range 1b ... 15b), which are acquired from the diluter via the analog interface and transferred to a PC via the serial interface. As we shall see, the linearity of these meters is not a necessary condition for obtaining very accurate results, in fact each test result is given by comparison of very near measurement.



Test Procedure:
- the names 1a, 2a, 4a, 8a, 15a indicate the theoretical flows through groups of 1, 2 ... 15 capillaries of the side "a" and similarly with the names 1b, 2b, 15b.. the corresponding flow in the capillaries of side "b".
- Ɛ1a, Ɛ2a, Ɛ4a, Ɛ8a, Ɛ15a, and the corresponding Ɛ1b, Ɛ2b, Ɛ4b, Ɛ8b, Ɛ15b relative errors are positive or negative, initially unknown, to be determined (the relative difference between the measured value and the theoretical value of flow).
1) assumes Ɛ1a = 0. All groups of capillaries are qualified with reference to the first single capillary
2) is measured sequentially the flow 1a and 1b later.
By the relationship 1a = 1b + Ɛ1b*1b is calculated Ɛ1b
3) are measured in sequence flows 1a+1b, 2a and 2b subsequently
by the relations 1a +1b-Ɛ1b*1b = 2a+Ɛ2a*2a = 2b+Ɛ2b*2b , is calculated Ɛ2a and Ɛ2b
4) are measured in sequence the flows 2a +2b, 4a and 4b subsequently
by the relations (2a +2b)-Ɛ2a*2a-Ɛ2b*2b = 4a+Ɛ4a*4a = 4b+Ɛ4b*4b is calculated Ɛ4a and Ɛ4b
5) are measured in sequence flows 4a+4b, 8a and 8b later
by the relations (4a+4b)-Ɛ4a*4a-Ɛ4b*4b = 8a+Ɛ8a*8a = 8b+Ɛ8b*8b is calculated Ɛ8a and Ɛ8b
6) are measured in sequence the flows 8a+8b, 15a and later 15b
by the relations [(8a+8b)-Ɛ8a*8a-Ɛ8b*8b]*15/16 = 15a+Ɛ15a = 15b+Ɛ15b is calculated Ɛ15a and Ɛ15b

This is also the suggested procedure to the accredited laboratory for metrological calibration.
The advantage of the above procedure is that the errors of flow are calculated by comparing two flows that are very close (identical capillaries indicate zero error) and therefore is totally unaffected by the error of non-linearity of the instrument meter. By contrast, the measures being performed in sequence, it is necessary that the meter and the external conditions (temperature) are stable during single phases of

tests (good repeatability and low short term drift). Changing phase, conditions may change, then the more suitable measuring range may be used in each testing phase.
The time required is less than 15 minutes, using laminating flow elements (less than one minute for each measurement phase), whereas, after the time of stabilization, analog data acquisition may be averaged with optimal accuracy.

TECHNICAL SPECIFICATIONS:

Dilutions:	all the combinations between 1:0:0 (just TG1), 0:1:0 (just TG2), 0:0:1 (just diluting gas)
Dilution Uncertainty:	(before calibration) better than 0,3% rel. + 0,03% of the input conc. (after calibration**) better than 0,1%rel. + 0,005% of the input conc. ** an additional error is due to calibrating laboratory uncertainty
Pressures regulation :	electronic type with PID function for $P_{(TG1)}$ - $P_{(OUT)}$, $P_{(TG2)}$ - $P_{(OUT)}$, $P_{(TG0)}$ - $P_{(OUT)}$, The three set points may be set independently with repeatability < ± 1 mbar
Flow of diluted gas:	about 4 liters / min. with pressures adjusted to 2000 hPa rel. Lower flows are obtainable by reducing proportionally the pressures set point. For special applications (low scale pilot plants) output flow may reach 12 L/min
Indicated measurements:	4 pressure measurements, acquired from 4 analyzers and two ancillary measures (ambient pressure and internal temperature).
Local interface:	color graphic display with touch screen
Remote interface :	RS485 port (with USB converter cable) and open protocol type AK Ethernet port
Calibrations:	with password access, pressure measurements may be calibrated (traceable pressure reference is non required) . Errors identified by metrological calibration may be fully compensated. A special PC driven procedure is available to calculate diluting errors by a series of measuring flows or concentrations (linearity is not mandatory for those measurements)
Construction:	The diluter is built in a 19" rack 3HU that may be optionally equipped with a lightweight but sturdy housing with carrying handle for protection against possible shocks,
Dimensions :	19 "Rack 3HU: 483 x 132 x 300 Weight approx 9 kg With shocks protecting case : 530 x 200 x 355 Weight 10 kg
Options:	Multiple selection of one of the two active gases (6 choices) and the diluent gas (2 choices)

The 19" rack version

Be.T.A. Strumentazione Srl
solo diluitori di gas, ma ...

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