Mean Time between Failures Analysis – Model SFC5400

- **Sensirion MFCs have an MTBF of 169 years**
- **The 90% lower MTBF confidence limit exceeds 1,200,000 hours**

The following report serves to analyze a sample of field data of the standard Sensirion Mass Flow Controller (MFC) platform gathered from the installed base of our clients. This information is employed to establish an estimate for the Mean Time between Failures (MTBF) for the SFC5400 series.

Results

The statistical analysis is conducted using a large sample of 4,724 Sensirion MFCs in operation during 2.5 years from January 2013 to July 2015. Within that time frame 42 failures were reported which constitutes less than 1% of the sample size. The operation time of an MFC is found from the estimated commission date until either failure or July 2015. The table below details the findings.

Time in:	Total operation time	MTBF	90% Lower Confidence Limit
Years	**7,100**	**169**	**138**
Days	2,591,580	61,704	50,236
Hours	62,197,920	1,480,903	1,205,652

Methodology

With 42 failures in 7,100 years of field operation, a time range of 169 years is the closest estimate for the MTBF of the Sensirion SFC5400 MFC series:

$$MTBF = \frac{t_{total}}{N_{failures}} = \frac{7100\ y}{42} \approx 169\ years$$

Furthermore, Sensirion can claim with 90% certainty that the true MTBF value lies in excess of 1,200,000 hours according to the MIL-STD-781C norm. The 90% lower confidence value for the MTBF may be used in order to estimate the MTBF of a whole system where the MFC is integrated.

In order to determine the MTBF of a specified sample, an adequate estimate of the operating time is required. For the above calculations, it was assumed that MFCs were commissioned one month after the delivery was dispatched. Moreover, after the start-up the components were presumed to operate 100% of the time until either the point of failure or the end of the time frame examined. Subsequently, the total number of days in operation was divided by the number of failures observed in the sample to evaluate the MTBF of the MFC. One further assumption made is that the reliability of a component has an exponential temporal dependency and hence the time rate of failures is constant. This implies operation in the flat segment of the 'bathtub' curve after the end of infant mortality, but before the start of wear out.

A failure rate of less than 1% within the first two and a half years indicates that Sensirion MFCs are long-living and robust instruments. This is underlined by the fact that only high quality components are used in the assembly: the valve – normally one of the most vulnerable components – is on average fully functional for more than 100,000,000 cycles setting new industry standards. If one cycle lasts 5s, this gives a service time of more than 15 years presuming uninterrupted operation. Similarly, the printed circuit board (PCB) with only 2 failures over the whole test period has an estimated MTBF of 3,969 years and from experience can remain in operation in excess of 20 years.

Failure prevention

Recent innovations in production technology mean that Sensirion MFCs now stand for even higher reliability because of enhanced contamination protection in clean room facilities. Warranty records demonstrate that malfunctions due to contaminated membranes – in 2010-2012 the second most likely cause for failure – have completely vanished since the new manufacturing standards have been adopted.