FM302 Wrong Duct Resistance Calculation → Insufficient Airflow

Chapter 3: Selection & Use — Fault model & typical case

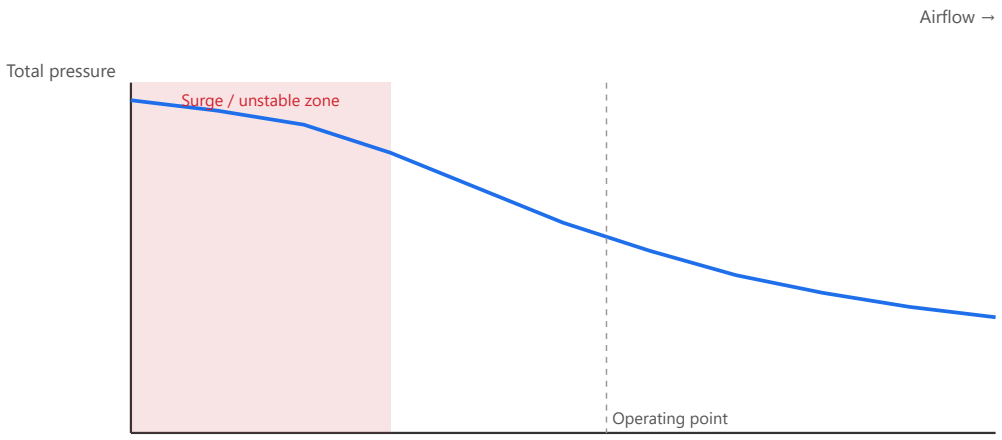
DOCUMENT
FM302

CHAPTER
Selection & Use

RELATED Q&A
3-60

PUBLISHER
Kunshan Best Machinery Equipment Co., Ltd.

Fault model + typical case. Mechanism, causes, symptoms, diagnosis, corrective actions and prevention are all anchored to the relevant entries of the Fan Engineering Q&A (see front matter for question references).



FM302 Wrong duct resistance calculation: the left-hand region is the surge / unstable zone (hump). Operating inside it causes surge, pressure pulsation and damage; selection and regulation must avoid it.

Failure Mechanism

The duct layout and resistance estimation are wrong (3-60 duct principles), so the resistance corresponding to the design airflow does not match reality; the fan operating point shifts and the system airflow becomes insufficient.

Common Causes

- Local resistance omitted from the calculation
- Deviation in actual pipe diameter / length

Failure Symptoms

- Insufficient airflow at the terminal points

Diagnosis & Evaluation

- Measure the actual system resistance curve

Corrective Actions

- Modify the duct network or the fan parameters

Preventive Measures

- Keep a reasonable margin in the resistance calculation

Typical Failure Case (Summary)

Case 1 (Real Case)

- Source unit / industry, time, duty: a smelter (flue-gas conveying), centrifugal fan with volume flow 346000m^3/h, total pressure 10000Pa and inlet temperature about 100 °C; the outlet duct system could not deliver the required airflow in actual operation, which constrained production.
- Failure symptoms: the measured actual flow was nearly 20% below the design value and the pressure nearly 6% above, so the fan operated at low airflow; in severe cases production was constrained and surge could even be triggered.
- Root cause: the duct resistance calculation accounted only for friction and local losses and omitted the additional system resistance near the fan outlet; by the conventional calculation the outlet duct loss was only 372Pa, but including the additional resistance it reached 672Pa (the additional resistance accounting for 44.6%), so the actual operating point deviated into the low-flow region.
- Corrective actions and result: the outlet duct was optimised by CFD flow-field simulation (adding a straight effective pipe section and reducing the outlet velocity); after the field modification the fan performed well and fully met the process design requirements.

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