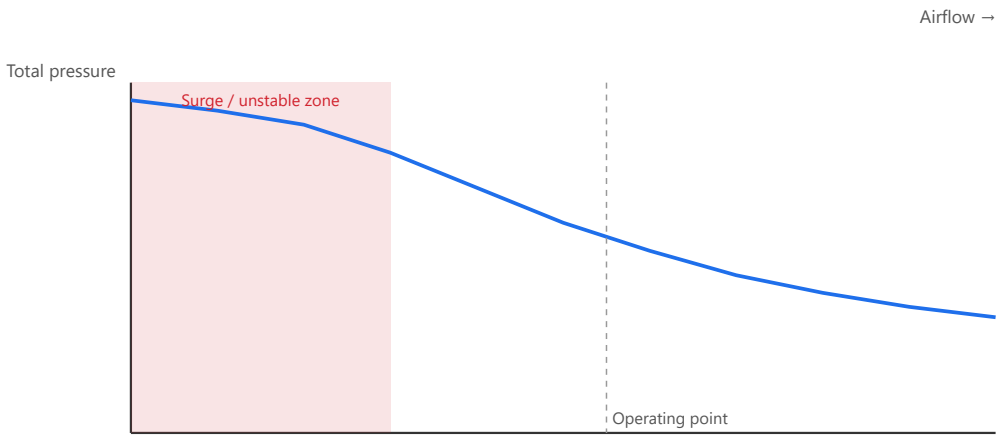
FM102 Low Air Density at Altitude → Insufficient Total Pressure

Chapter 1: Gas Properties — Fault model & typical case

DOCUMENT	CHAPTER	RELATED Q&A	PUBLISHER
FM102	**Gas Properties**	**1-07, 1-05**	**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).



FM102 Low Air Density at Altitude: the left-hand region of the curve is the surge / unstable zone (hump). If the operating point falls inside it, surge, pressure pulsation and equipment damage occur; selection and regulation must avoid it.

Failure Mechanism

As elevation increases, atmospheric pressure drops (1-07), and the total pressure the fan can deliver (see 1-05 for the absolute / gauge pressure relationship) declines in relative terms. The effective head available to overcome the duct resistance decreases, so the system shows insufficient suction / delivery force on the plateau.

Common Causes

- No atmospheric-pressure correction applied to plateau projects
- Catalogue performance stated at sea-level standard conditions
- Seasonal winter / summer barometric variation not taken into account

Failure Symptoms

- Fan pressure and airflow at the plateau site fall short of the nameplate values
- Insufficient positive / negative pressure at the duct terminal

Diagnosis & Evaluation

- Check the local annual mean atmospheric pressure
- Re-verify the effective head with the Bernoulli equation / equation of state

Corrective Actions

- Raise the total-pressure rating of the fan or increase the impeller diameter
- Add a booster stage where necessary

Preventive Measures

- For high-altitude projects, state the atmospheric-pressure correction explicitly in the selection specification

Typical Failure Case (Summary)

In one project a single-inlet backward-curved centrifugal fan originally operated at an elevation of 800 m with an ambient temperature of 60 °C (air density coefficient 0.80), requiring a static pressure of 900Pa; an XS type fan was selected (933r/min, 11kW). Later the equipment was moved to an elevation of 3000 m (density coefficient 0.59), where the static pressure demand rose to 1525Pa. The static pressure of the original fan was clearly insufficient, and both the motor and the sheave had to be replaced (1061r/min, 15kW) before the duty could be met. Root cause: the local atmospheric pressure and air density were not corrected as the elevation rose, so the fan total pressure decayed in proportion to the density and the sea-level model lost output on the plateau.

In Tibet and Qinghai, many schools and supermarkets use forward-curved centrifugal fans for fresh-air projects. The thin air on the plateau makes the fan pressure at the same speed and same impeller decay as elevation rises (about a 10% pressure drop at 1000 m and about 30% at 3000 m), so ordinary sea-level models are short of fan pressure on site. By accurately calculating the fan-pressure decay coefficient for the elevation, custom-manufacturing enlarged forward-curved models and reserving a 25%~35% margin, the field-measured parameters meet the requirements.

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