

detectors and alarms for heat, fire, or smoke should be installed in a "fail-safe" manner.

E. COST ANALYSIS

A comprehensive cost analysis for air or gas cleaning will include most of the following items:

1. Noninstalled cost per unit air-flow capacity.
2. Installation cost including discharge stack.
3. Amortization based on known service life.
4. Fixed charges on space required by equipment.
5. Initial costs for disposal equipment.
6. Operating costs for disposal of wastes.
7. Preventive and corrective maintenance costs.
8. Scrubbing liquid costs.
9. Power or utility costs.
10. Recovery or salvage value of constituents.

Approximate information on the first item appears in Table 3. These data

TABLE 3
Cost of Air or Gas Cleaners*
(Dollars per 1000 c.f.m.)

Type of cleaner	Minimum noninstalled cost
Inertial separators	
Baffle chambers (gravity-inertial)	50
Cyclones (single, large diameter)	100
Cyclones (multiple, small diameter)	400
Fan-type (dry)	200
Filters	
Cloth baghouse (above 10,000 c.f.m.)	500
Reverse-jet cleaned (above 10,000 c.f.m.)	800
Unit air-supply ("throwaway")	10
Conveyorized impingement type	100
Active carbon (odor removal)	200
Electric precipitators	
Single-stage high-voltage (above 100,000 c.f.m.)	500
Two-stage low-voltage (air conditioning)	200
Scrubbers and washers	
Spray chambers	100
Cyclone scrubbers (stationary)	300
Mechanical or dynamic	500
Packed towers (chemical absorbers)	1000
"Disintegrator" scrubbers	3000

* Approximate minimum noninstalled costs, using ordinary steel construction; installed costs, complete with necessary auxiliaries, may be at least twice the figures given here, based on 1955 prices.

are given to indicate the wide range of costs encountered by the application engineer and to serve as a warning against hasty estimates. Even greater ranges of costs are experienced when the items mentioned above are included in the analysis.

F. POWER REQUIREMENTS

The energy consumed in cleaning air or gas is largely the power required to force the fluid through the system against the resistance of numerous obstructions placed in the stream to stop the air-borne matter. Table 4 presents the order of magnitude of pressure drop encountered with the several types of cleaning equipment. Along with pressure drop is given the estimate of power required, in kilowatts, to force 1000 cubic feet of air through the equipment in one minute against the specified resistance.

It is evident that no simple correlation exists between power consumption and separation ability for fine particles. However, for those mechanisms depending primarily on centrifugal force, the power requirement will rise as separation factor increases, resulting in more effective performance against the smallest particles.

TABLE 4
Power Requirements for Air-Cleaning Equipment

Equipment type	Pressure drop (in. H ₂ O)	Kilowatts required per 1000 c.f.m. air capacity*
Gravity settling chambers	0.05-0.2	0.02-0.1
Spray chambers	0.05-0.2	0.02-0.1
Electric precipitators	0.05-0.5	0.02-0.2
Impingement filters	0.5-1	0.2-0.5
Packed towers (wet)	0.5-5	0.2-2
"Absolute" filters	1-5	0.3-2
Cloth arrestors	2-6	0.5-2
Cyclone separators	1-5	0.3-2
High-velocity centrifugals	3-15	1-5
Intensive scrubbers	2-30	1-10

* Do not include power to force air through duct system or to disintegrate scrubbing liquid by mechanical or hydraulic methods.

General References

American Chemical Society, Symposium on Atmospheric Contamination and Purification: (a) Deposition of aerosol particles from moving gas streams, H. F. Johnstone and M. N. Roberts, (b) Development of the Venturi scrubber, W. P. Jones, (c) Electrical precipitation and mechanical dust collection, W. A. Schmidt, (d) Agglomeration of smoke, fog, or dust particles by sonic waves, H. W. St. Clair, (e) Industrial sonic agglomeration and collection systems, H. W. Danser and R. Neumann, *Ind. Eng. Chem.*, 41, 2383-2493 (November, 1949).