Application Database

GARDNER DENVER

Centrifugal Products Group

Industry: Mining

Application: Minerals Processing

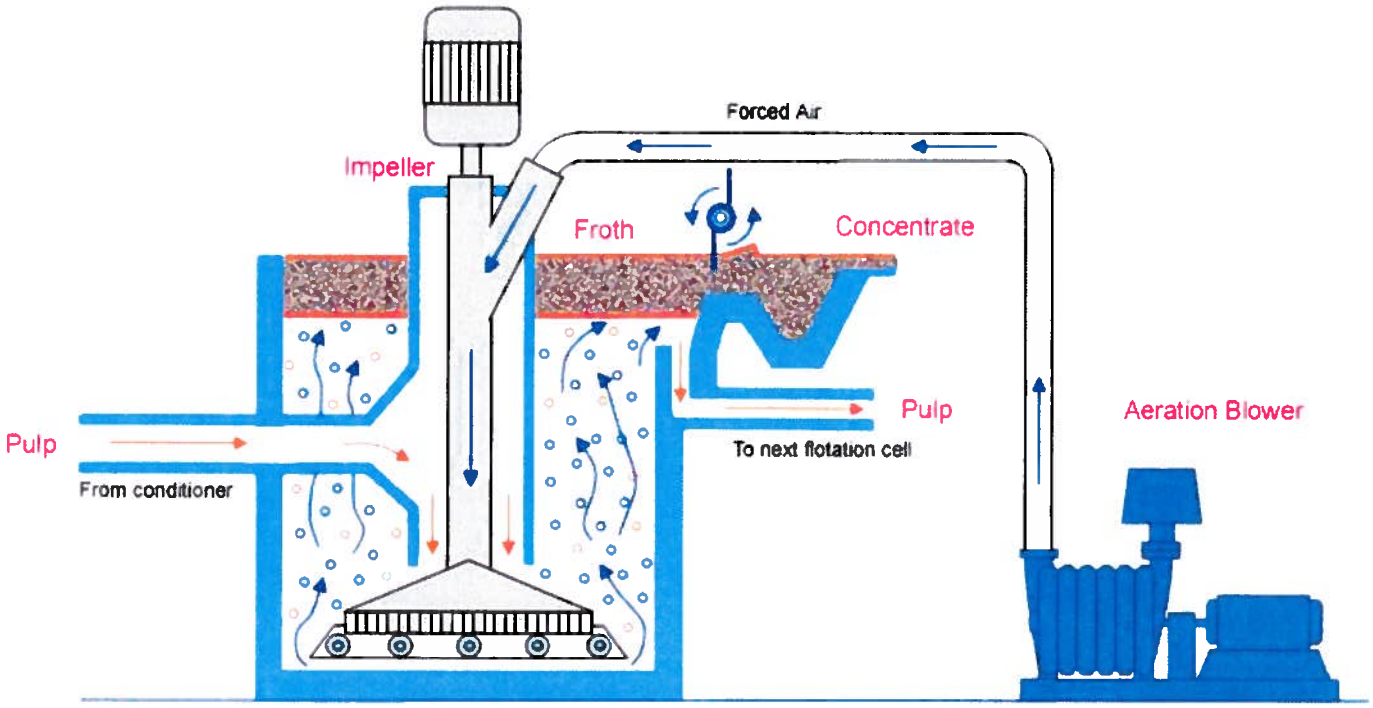
Process: Ore Flotation Cells

Valuable minerals in an ore can be separated from each other and from worthless components by the froth flotation process. Flotation is a key process in the recovery of most of the world's copper, lead, molybdenum, nickel, platinum group elements, silver and zinc, and in the treatment of certain gold and tin ores. The first step in the flotation process involves crushing the ore. The powder is then mixed with water and chemicals, and the resulting pulp or slurry is fed to a series of flotation cells. Most flotation is carried out in large tanks ranging in volume up to 9,000 ft^3 (250 m^3). The mineral surfaces are made hydrophobic (water repellent) by conditioning with selective chemical reagents. Centrifugal blowers provide air to the cells, and the cell contents are mechanically mixed with an agitator to shear the air into bubbles. The bubbles attach to the hydrophobic particles and naturally move upward where they collect in a froth layer at the top of the cell.

Plants consist of multiple banks of cells, and the process for each stage usually involves 3 steps. In the first group of cells, termed the ***rougher*** circuit, most of the mineral to be floated is recovered. This concentrate is then refloated in a ***cleaner*** circuit to make a more pure product. The ***sink fraction*** from the roughing stage is sent to a ***scavenger*** circuit, and the subsequent float fraction is returned, together with the sink fraction from the cleaners, to the roughers to avoid losing valuable minerals.

Not only does the flotation process enable valuable sulfide minerals to be concentrated from worthless material that make up the ore matrix, but it also allows different sulfide minerals to be separated from each other. Different types of chemical reagents are used to either make mineral particles hydrophobic and rise with the air bubbles or to impede the flotation of minerals by depositing a wetting layer on their surfaces.

The flotation process has been continuously developed throughout the 20th century and into the 21st century to increase the efficiency of separation and to treat more complex ores. More selective chemical reagents are used, and the pulp chemistry has been adjusted to achieve optimum separations and recoveries.



Ore Flotation Cells

Application Database

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Description: Multistage centrifugal blowers are used to supply forced air creating small air bubbles which attach to the conditioned ore particles, floating to the surface and forming a valuable froth layer.

- Gas Composition: Air
- Operating Conditions: Multistage centrifugal blowers, typically operating at higher elevations and ranging from 3,000 to 20,000 cfm and generally in the 4-7 psi range
- Sizing Criteria: CF Select will determine the most efficient or cost effective blower for each situation

Competitors:

Manufacturer	Technology
Spencer	Centrifugal blower
HSI	Centrifugal blower
Continental	Centrifugal blower
Hibon	Centrifugal blower

Gardner Denver Products:

- Marketing Position: Lamson and Hoffman multistage centrifugal blowers are the most well known brand names in the flotation cell industry and have the best reputation for longevity and service.
- Differentiation Strategy: Worldwide sales and service support
- Advantages: Multistage centrifugal blowers are custom-made and designed to deliver a specific airflow and pressure. If the airflow and pressure remain the same, multistage centrifugal blowers can be very efficient.
- Disadvantages: Multistage centrifugal blowers can be expensive. The market typically tries to use fans at lower required pressures and at lower elevation sites.

Key Users:

- Metallurgical processors of gold, copper, nickel and other metals extracted through the flotation process
- Flotation cell manufacturers such as Outokumpu, Metso Minerals, Dorr-Oliver Eimco and FL Smidth (Fuller)
- Engineering, Project Management and Construction companies such as SNC-Lavalin, Bechtel, Fluor Corp., Aker Kvaerner

More Information:

Contact Marketing Services for the following:

- Sales brochure *Multistage Centrifugal Blowers/Exhausters* (GDCF-1-300)

FROTH FLOTATION CELL

Froth flotation is a process for selectively separating minerals from gangue by taking advantage of differences in their hydrophobicity. Hydrophobicity differences between valuable minerals and waste gangue are increased through the use of surfactants and wetting agents. The selective separation of the minerals makes processing complex (that is, mixed) ores economically feasible. The flotation process is used for the separation of a large range of sulfides, carbonates and oxides prior to further refinement. Phosphates and coal are also processed upgraded by flotation technology.

The flotation process is also widely used in industrial waste water treatment plants, where it is removes fats, oil, grease and suspended solids from waste water. These units are called Dissolved air flotation (DAF) units.[1] In particular, dissolved air flotation units are used in removing oil from the wastewater effluents of oil refineries, petrochemical and chemical plants, natural gas processing plants and similar industrial facilities.

APPLICATION CODE: 33

APPLICATION TYPE: Exhausting, mining

MAJOR CUSTOMERS: Island Creek Coal, Wahlco International Inc., Oakwood Gathering

TYPICAL GAS MIXTURE: Methane

TYPICAL BLOWER FRAMES: Exhausters 310-1250

KEY FEATURES: Gas tight, flammable

MAIN COMPONENT GROUPS:

1. *Shaft:*
Steel

2. *Bearing housing:*
Closed

3. *Lubrication:*
Grease or oil

4. *Seal:*
Packing box or double carbon ring seal

5. *Inlet/outlet heads:*
Gray cast iron

6. *Sections:*
Gray cast iron

7. *Impeller:*
Aluminum, 355 T6

8. *Baffle ring:*
Brass, electroless Nickel plated

9. *Balance piston /cylinder:*
Ductile iron / Steel & lead

MOST COMMON OPTIONS:

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SPECIFICATION 1:

SO# 67988 Island Creek Coal Company (1997) See 64247
Coal bed methane wells
Blower type: 858, 60 Hz
Gas mixture:?

Inlet / Outlet temperature: F / F
Inlet / Outlet pressure: / PSIG

Non standard Lamson specifications:
Outlet drive.
Closed end bearing cap (long lip)
Outlet with drain and plug
Intermediate with drains and cleanout, SST pipe plugs
Reliance 125 HP motor, TEFC, frame 444TS
Brass baffle rings

SPECIFICATION 2:

SO# 65356 Oakwood Gathering Inc. (1995)
Blower type: three 1257 exhausters
Gas mixture: Methane CH_4

Inlet / Outlet temperature:
Inlet / Outlet pressure:

Non standard Lamson specifications:
Labyrinth
Grease
Outlet head with drains and sections with drains and cleanouts
Brass baffle rings and hardware
Customer provided his own 250 HP XP 447 TS motor.

SPECIFICATION 3:

SO# 65101 Wahlco International, Inc.
Blower type: 554, 2950 RPM

Gas mixture: air

Inlet / Outlet temperature: 68 F/
Inlet / Outlet pressure: 14.7 PSIA / 2.8 PSIG

Non standard Lamson specifications:
Outlet driven, oil lube
¼" pilot holes in inlet and outlet flanges
Labyrinth
Reliance 20 HP TEFC motor, frame size 256T
Woods Sureflex coupling

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*    SMARTPIK II - AUTO BLOWER MECHANICAL SELECTION      *
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GENERAL:
 DATE =                5/21/98          ENGINEER =          Helene B

BLOWER:
 BLOWER FRAME:         850              # of STAGES =        8
 Outlet Pres, psig =    6.0             Outlet Temp, F =    300
 Inlet Position =      2                Outlet Position =   3
 Bearing Model =       6312

MAJOR DIMENSIONS, inches:
 Inlet Flange =         8.0             Outlet Flange =      8.0
 Shaft Dia =           3.25             Stg Spacing =        4.13
 B DIMENSION =         40.47            A DIMENSION =       36.04
 BLOWER HEIGHT =       44.75            BLOWER WIDTH =      38.13

WEIGHTS, MOMENT OF INERTIA & CRITICAL SPEED:
 BLOWER WT, lb =        2807            ROTOR WT,lb =        384
 ROTOR WK2, lb-ft^2 =                   125.0
 CRITICAL SPEED, rpm =                  4377

PRICES:
 BLOWER (standard material) =                    US$    8562.0
 Non-Standard material =                         US$   10630.0
 Options =                                       US$    1600.0
 TOTAL BLOWER PRICE =                            US$   31188.0

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APPLICATION:
 APPLICATION CODE:    33
 CATEGORY:            Exhausting & Venting
 APPLICATION:         Mine Venting
 DESCRIPTION:         Natural Gas & Air, flammable

BLOWER CONSTRUCTION (MATERIALS & OPTIONS):
 SHAFT:               AISI-4140 STEEL
 BEARING HOUSING:     OPEN STYLE, CAST IRON
                        - WITH VIBRATION PROBE
                        - WITH TEMPERATURE PROBE
                        - WITH HEAT SHIELD
 LUBRICATION:         GREASE LUBRICATION
                        - High Temp Grease
 SHAFT SEAL:          DOUBLE CARBON RING
                        - WITH PRESSURE PURGE
 INLET/OUTLET HEADS:  GREY CAST IRON (ASTM A48 GRADE 25/30)
 SECTION:             GREY CAST IRON (ASTM A48 GRADE 25/30)
 IMPELLER:            FABRICATED STEEL
 BAFFLE RINGS:        BRASS WITH ELECTRO NICKEL
 BALANCE PISTON:      NONE, NOT NEEDED
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HONGKONG ELECTRIC
LAMMA STATION, UNITS 6 & 7
WAHLCO JOB NO. 1-965/2-222
REV 0, 1/12/95

WAHLCO SPECIFICATION
FOR
LAMSON AIR BLOWER WITH BASE FRAME

1. Blower: Lamson Model No. 554 Air Blower with 1001 Impellers and air outlet driven configuration. Blower bearings shall be oil lubricated. Blower inlet connection to be 6" -150 lbs. F.F. flange, oriented in position No. 1, discharge connection to be 5" - 150 lbs. F.F. flange oriented in position No. 1. Inlet and outlet flanges shall be drilled with pilot holes only. Blower shall deliver 815 CFM (68°F @ 1 ATM) and 2.8 psig discharge pressure when driven at 2950 RPM and shall also deliver 815 CFM (68°F @ 1 ATM) and 4.3 psig discharge pressure when driven at 3525 RPM during the shop test. Blower will be driven by 15 KW (20 HP), 2950 RPM motor. 25 HP, 3600 RPM motor will be used for test.

2. Motor: Motor will be furnished by Wahlco to be mounted on the base and coupled to the blower by Lamson. Motor will be 15 KW (20 HP) TEFC, Frame size 256T, 415 volts, 50 Hz, 3-phase, 2950 RPM, Reliance Electric Motor.

3. Shaft coupling shall be Woods Sureflex coupling, sized to match the blower HP and RPM.

4. Shaft guard shall completely enclose all rotating parts, from motor to blower bearing housing.

5. Base shall be Lamson standard fabricated base. Prepare base to receive Wahlco supplied motor.

6. Blower, motor, and base skid shall be tested for vibration at 2950 and 3525 RPM. Motor mounting frame must be reinforced.

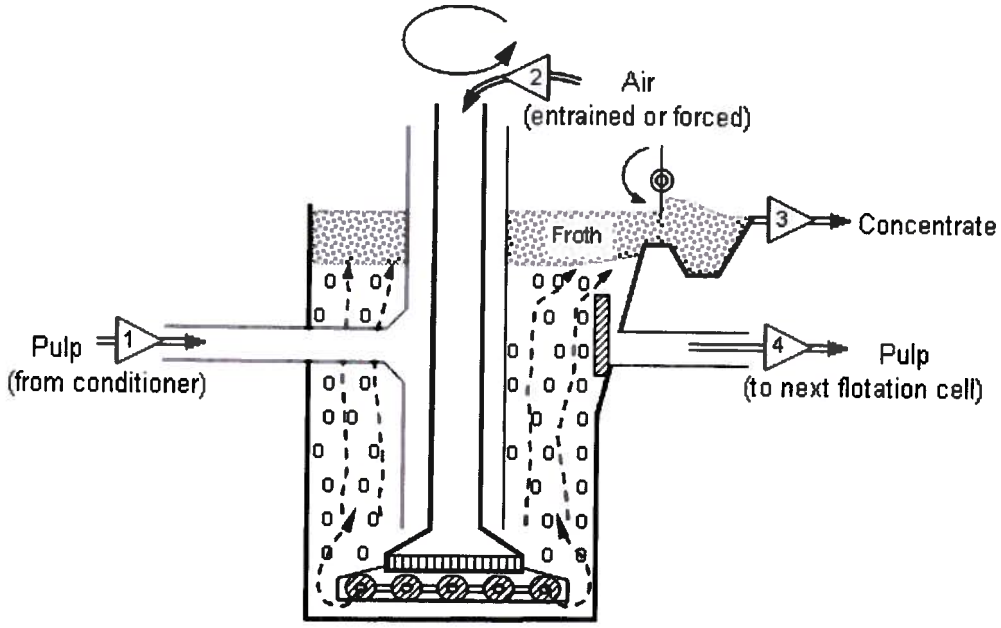
7. Complete assembly shall be mechanically cleaned and primed with one coat of primer and painted with two coats of epoxy ASA 61 gray paint.

8. A certified drawing of the complete unit (blower, motor, coupling and base) together with a Bill of Material showing all component parts and vibration test data shall be furnished for each order.

9. Fifteen (15) sets of Manufacturer's Service Literature (original only) including spare parts list shall be furnished for the blower, motor and coupling.

FROTH FLOTATION PRINCIPLES

Froth flotation commences by comminution (that is, crushing and grinding), which is used to increase the surface area of the ore for subsequent processing and break the rocks into the desired mineral and gangue in a process known as liberation, which then has to be separated from the desired mineral. The ore is ground into a fine powder. The desired mineral is rendered hydrophobic by the addition of a surfactant or *collector chemical*. The particular chemical depends on which mineral is being refined. As an example, pine oil is used to extract copper (see copper extraction). This slurry (more properly called the *pulp*) of hydrophobic mineral-bearing ore and hydrophilic gangue is then introduced to a water bath which is aerated, creating bubbles. The hydrophobic grains of mineral-bearing ore escape the water by attaching to the air bubbles, which rise to the surface, forming a foam or a scum (more properly called a *froth*). The froth is removed and the concentrated mineral is further refined.



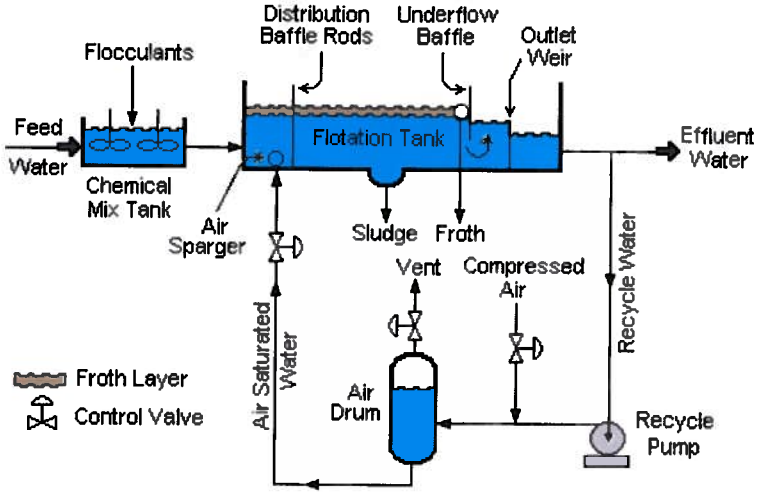
Flotation can be performed in mechanically agitated cells or tanks, in tall flotation columns and in several other units including the Jameson cell.

Mechanical cells use a large mixer and diffuser mechanism at the bottom of the mixing tank to introduce air and provide mixing action. Flotation columns use air spargers to introduce air at the bottom of a tall column while introducing slurry above. The countercurrent motion of the slurry flowing down and the air flowing up provides mixing action. Mechanical cells generally have a higher throughput rate, but produce material that is of lower quality, while flotation columns generally have a low throughput rate but produce higher quality material. **Mechanical flotation cell used for mineral concentration.** Numbered triangles show direction of stream flow. A mixture of ore and

water called pulp [1] enters the cell from a conditioner, and flows to the bottom of the cell. Air [2] or sometimes nitrogen is passed down a vertical impeller where shearing forces break the air stream into small bubbles. The mineral concentrate froth is collected from the top of the cell [3], while the pulp [4] flows to another cell.

The Jameson cell uses neither impellers nor spargers, instead combining the slurry with air in a downcomer where high shear gives excellent bubble particle contacting.

In dissolved air flotation (DAF), which is used in wastewater treatment, air is dissolved into the flotation solution under high pressure. When the solution is released into the flotation chamber, the reduced pressure causes much of the dissolved air to come out of solution to form bubbles in the same way that dissolved carbon dioxide forms bubbles when a beer bottle is opened.



The following steps are followed:

1. Grinding to liberate the mineral particles
2. Reagent conditioning to achieve hydrophobic surface charges on the desired particles
3. Collection and upward transport by bubbles in an intimate contact with air or nitrogen
4. Formation of a stable froth on the surface of the flotation cell
5. Separation of the mineral laden froth from the bath (flotation cell)

Simple flotation circuit for mineral concentration. Numbered triangles show direction of stream flow, Various flotation reagents are added to a mixture of ore and water (called pulp) in a conditioning tank. The flow rate and tank size are designed to give the minerals enough time to be activated. The conditioner pulp [1] is fed to a bank of rougher cells which remove most of the desired minerals as a concentrate. The rougher pulp [2] passes to a bank of scavenger cells where additional reagents may be added. The scavenger cell

froth [3] is usually returned to the rougher cells for additional treatment, but in some cases may be sent to special cleaner cells. The scavenger pulp is usually barren enough to be discarded as tails. More complex flotation circuits have several sets of cleaner and re-cleaner cells, and intermediate re-grinding of pulp or concentrate.