GENERAL PRESENTATION

AIR POLLUTION
CONTROL SOLUTIONS
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Fives, a trusted partner to many leading industrial segments

Fives, an industrial engineering Group, designs and supplies machines, process equipment and production lines for the world’s largest industrial players. Its multisector offer is presented through 18 business lines.

$3,100 million of order intake
$197.7 million of EBITDA
$2,776 million of sales

BREAKDOWN OF SALES BY END MARKET

21% Automotive
30% Energy
28% Logistics
16% Metals
12% Aerospace and industry
3% Other

BREAKDOWN OF SALES BY GEOGRAPHICAL AREA

37% Asia / Oceania
30% Africa / Middle-East
16% Europe
16% The Americas
12% North America
3% Latin America
3% Asia / Oceania

A WORLDWIDE NETWORK OF SUBSIDIARIES

8,700 employees
more than 100 operational subsidiaries and regional offices in about 30 countries

Fives, an international organization

- Expert teams located worldwide
- Renowned expertise in international project management

SAFETY, A DRIVER FOR OPERATIONAL EXCELLENCE

75% subsidiaries audited
67 HSE Professionals

SERVICES, TO ENSURE PERFORMANCE DURING THE LIFE TIME OF YOUR INSTALLATION

Understanding our clients’ operations is the best way to offer them customized service solutions that will increase their return on investment

$51.1 million spent on R&D
2,169 patents in force
13% of patents application relating to energy and environmental performance

$2,776 million of sales
$197.7 million of EBITDA
$3,100 million of order intake

Figures dated 2017
Fives, an extensive experience in Air Pollution Control Technologies

AIR POLLUTION CONTROL ACTIVITY

$1 to 200 million

project range

Around 150

employees

14+

target industries

FRANCE CANADA USA

1949 1982 1996

PARIS MONTREAL DENVER

PROVEN TECHNOLOGIES, WELL POSITIONNED OVER THE AIR POLLUTION CONTROL MARKET

SOLUTIONS

Gas Treatment Process

Dedusting

Dry Scrubbing

Hybrid Scrubbing

Technologies

SONAR™

TGT™

OZEOS

TGT-R™

AD™

EAD™

AD-NOx™

EAD-NOx™

Reagents injection

-hydrated lime, sodium bicarbonate, Alumina...

Hybrid Systems

+ Fabric Filter

+ Fabric Filter

+ Fabric filter

Particulates, Ash

SO₂, SO₃

HCl

HF

Tars

Mercury (Hg) and other heavy metals

Dioxins / Furans

NOₓ

HCN, H₂S, COS, NH₃

Reagents injection

-hydrated lime, sodium bicarbonate, Alumina...

+ Activated Carbon

+ Activated Carbon

Catalytic bags

Catalytic bags or SCR

+ Wet Scrubber + Cyclone

MARKETS

WASTE & BIOMASS

Gasification / Syngas

Incorporation

LIME

Horizontal Kilns

Vertical Kilns

CEMENT

Kilns

Alkal by-pass

Raw mill

Finish mill

ESP conversions

Clinker cooler

ALUMINIUM

Electrolysis Pots

Anode Baking Furnace

Green Anode Plant

Secondary casthouse

OTHER MINERALS

Calciner

Process Kilns

Furnaces

OTHER INDUSTRIES

Coal

Boilers

Brick

Proppants

Steel

Iron Ore

Pet Coke

Glass

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Fives, an extensive experience in Air Pollution Control Technologies
The Sonair™ Filter has been used for the last decades in many applications and remain a very reliable and proven baghouse technology for specific applications.

Fives’ dust control solutions consist in proprietary baghouse filters, designed by our engineers to remove particulates out of air or gas generated by industrial or combustion processes. We have more than 60 years of experience designing and manufacturing bag filters, for the renowned players of the industry. This extensive expertise allows us to provide the most reliable and efficient systems on the market.

SONAIR™
- Bag filter system equipped with bags up to 5 meters length
- High pressure pulse cleaning technology
- High efficiency at an economical cost
- Uniform leading of the whole filter surface
- Lateral gas flow distribution onto bags

TGT® FABRIC FILTER
- Bag filter system using long bags (6, 8, 10 + meters)
- Low pressure pulse cleaning technology
- Very high efficiency
- Compact footprint
- Process stability using adaptive “online” cleaning sequence

Fives was the first to develop this long bag technology to the cement market more than 20 years ago and has become the industry benchmark for high efficiency particulate removal equipment.

Dedusting Solutions
Bag Cleaning

- Pulse jet cleaning valves
- Automatic filter bags cleaning according to filter’s differential pressure
- Automatic bag leakage detection system (row detection)
- High or low bag cleaning pressure
- Optimized for extended bag life
- Seam-sealed bags
- Fully welded tube sheets
- Very low can velocities by splitting inlet gas flow.

ESP CONVERSION

ESP or Electrostatic Precipitators are considered obsolete by most Air Pollution Control experts. Their lower efficiency and high CAPEX made them disappear from the dust control companies’ catalogs. As the particulate emission regulations are becoming more and more stringent, many industrials that already have ESPs installed need to add a second filtration system (ESP, baghouse filter...) to comply with the emission requirements.

Fives offers a complete service of ESP conversion into a baghouse filter with many relevant advantages:
- Considerable increase in particulate and dust removal efficiency
- Upgrade costs reduction
- Footprint optimization
- Access to Fives’ large range of after sales services
Fives’ Dry Scrubbing solutions consist in combining reagent injection systems with a proprietary bag filter to control a wide range of pollutants. The main pollutant removal takes place in our Venturi reactors. Formed around the bags, the filter cakes provide a secondary stage of scrubbing to achieve very high efficiencies.

**TGT-RI® FABRIC FILTER**
- Reactor integrated inside the filter module
- Optimal distribution of the reagent (only alumina) and the gases
- Highly efficient
- Only used in the aluminium industry
- Perfectly adapted for GTCs with high requirements (gas flowrates up to 2,500,000 Nm³)
- Suitable in all climate conditions

**OZEOS**
- Very large capacity filter
- Baghouse filter with improved integrated low velocity reactor
- Integrated reactor for compact footprint
- Enhanced alumina handling with external recirculation
- Drastically reduced gas velocity inside the filter
- Longer bag life
- Fives Engineered Sustainability brand

**Venturi Reactors | Reagent injection**
- Dry powder reagent injection
- Reaction device for intimate contact between acid gas and reagent
- Operates with low pressure drop
- Recycled material handles peaks in acid gas

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**Comparison with benchmark technologies**
Optimum balance between compact design and performance

- **+30%** Enhanced bag life
- **-5%** electrical consumption in GTC
- **-20%** HF emissions

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**Dry-Scrubbing Solutions**

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1 Humidified recycled reagent
2 Hot, dry flue gas
3 Cooled, humidified flue gas
Dry-Scrubbing Solutions

ALL-DRY SCRUBBING SYSTEM (AD™)

— This Dry Scrubbing system combines a reagent injection system and a proprietary venturi reactor with a TGT® or Sonair™ filter to collect particulates and reacted reagent
— All-Dry scrubber: bag filter + reagent injection system + Venturi Reactor
— Pollutant neutralization in the Venturi Reactor
— Cost effective solution
— The filter cake on the bags provides a secondary stage of scrubbing

Pollutants removed:
Particulates, ash, SO₂, SO₃, HCl, HF, mercury, dioxins/furans, heavy metals, VOCs

ENHANCED ALL-DRY SCRUBBING SYSTEM (EAD™)

— The Enhanced All-Dry (EAD™) scrubbing system combines an All-Dry with a reagent recirculation loop that includes our proprietary Conditioning Drum for increased SO₂ scrubbing efficiency
— Enhanced All-Dry Scrubber: bag filter + reagent injection system + Venturi reactor + reagent recirculation loop + Conditioning Drum
— Pollutants neutralization in the Venturi Reactor
— The Conditioning Drum is the key feature of the EAD™ scrubbing process
— Higher scrubbing efficiency and optimized reagent consumption
— The filter cake on the bags provides a secondary stage of scrubbing

Pollutants removed:
Particulates, ash, SO₂, SO₃, HCl, HF, mercury, dioxins/furans, heavy metals, VOCs
Dry-Scrubbing Solutions

SOLIOS CONDITIONING DRUM

The Conditioning Drum is an essential feature of the EAD™ Scrubbing Process. This proven equipment, developed from extensive testing, enhances the acid gas removal efficiency of the conventional All-Dry Scrubbing Process.

Operating principle of Enhanced All-Dry Scrubbing

— Use a high rate of reagent recirculation
— Recycled reagent is humidified in a Conditioning Drum by water fog nozzles
— Humidified recycled reagent mixture is injected in the reactor
— Water is quickly evaporated cooling the inlet gas by 20° C to 50° C for optimized neutralization temperature
— Flash cooling of reagent due to evaporation favors the reaction of SO₂ with lime.

Dry-Scrubbing (DeNOx) Solutions

AD-NOx™ SYSTEM

— AD™ + Catalytic bag filter + ammonia/urea injection system
— NOx control within the All-Dry Scrubber
— No SCR needed to achieve the DeNOx
— Important CAPEX reduction
— The catalytic filter elements neutralize the NOx and capture the particulates and the reagent
— Efficient for control of multiple pollutants

Catalytic bags | Candle Filters

Particles
• NOx
• NH₃
• Dioxins
• CO

Clean gas side
• CO₂
• N₂
• H₂O
• O₂

EAD-NOx™ SYSTEM

— EAD™ + catalytic bag filter + ammonia/urea injection system + heat exchanger
— NOx control within the Enhanced All-Dry Scrubber
— No SCR needed to achieve the DeNOx
— Higher scrubbing efficiency and optimized reagent consumption
— The catalytic filter elements neutralize the NOx and capture the particulates and the reagent
— Efficient for control of multiple pollutants
Dry-Scrubbing Solutions Efficiency

- SO₂ removal efficiency: >99%
- HCl/HF removal efficiency: >99%
- NOx removal efficiency: >99%
- Water discharge: 0
- Treated air flow: 10K to 2M Nm³/h
- Particulate emissions: as low as 2 mg/Nm³

HYBRID SYSTEM

- Fives’ Hybrid System combines one of our dry scrubbing solutions to other technologies (cyclones, SCR, SNCR, wet scrubbers...) in the same process
- A technology adapted to very demanding and stringent industries such as Waste-to-Energy and Syngas
- The highest efficiency
- Multi-pollutant control:
  - Particulates, ash, tar, SO₂, SO₃, HCl, HF, NOₓ, mercury, dioxin/furans, heavy metals, VOCs (Removed with zero water discharge)
  - HCN, H₂S, COS and NH₃

Optimized reagent and electrical consumption

Flexible and compact customized design

High efficiency multi-pollutant control
Services

Fives can supply or design several other solutions according to the needs of our projects, to perfectly meet our clients’ requirements:

— Injection systems
— Conditioning towers
— Wet Scrubbers
— SCR and SNCR
— Fans
— Oxidizers: Catalytic Oxidizers (CO), Regenerative Thermal Oxidizers (RTO), Thermal Oxidizers (TO)

TURNKEY PROJECT MANAGEMENT

— Detailed engineering
— Supply of key process equipment
— Project monitoring
— Installation supervision
— System commissioning

OPERATION

— Project monitoring
— Remote monitoring
— Technical audit of your air pollution control installation
— Spare parts supply

EVOLUTION

— Upsizing of your installation
— EAD™ and AD™ retrofitting to re-use an existing dust collector
— Improvement of the cleaning capacities

OPTIMIZATION

— Bag cleaning process optimization
— Reagent and power consumption optimization

Latest references

WASTE-TO-ENERGY AND GASIFICATION PROJECTS

— 2017
  - EAD™ - OUTOTEC RDF Gasifier - Barry, U.K.
  - EAD™ - OUTOTEC RDF Gasifier - Hull - U.K.
  - EAD™ - OUTOTEC - RDT Gasifier - Boston - U.K.
— 2016
  - Hybrid ALL-DRY scrubber - Beacons, FRANCE.

ALUMINIUM PROJECTS

— 2017
  - OZEOS-SONAIR™ - ALBA - Manama, BAHRAIN.
— 2016
  - SONAIRM - XINFA - Xinyuan, CHINA.
— 2015
  - OZEOS - RIVA - Petrin, RUSSIA.

CEMENT PROJECTS

— 2017
  - TGT® - CIMENT-QUEBEC - St-Basile de Port-Neuf, CANADA.
— 2015
  - TGT® - ARMSTRONG CEMENT - Cabot, USA.

MINERAL AND OTHER PROJECTS

— 2015
  - EAD™-TGT® - ST-GOBAIN - Bryant, USA.
— 2011
  - EAD™-TGT® - ST-GOBAIN - Fort Smith, USA.
— 2007
  - EAD™-TGT® - VERRINIA TECH - Blacksburg, USA.
— 2006
  - EAD™-SONAIR™ - GENERAL SHALE 2 -
A worldwide presence

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