AIR POLLUTION CONTROL SOLUTIONS

GENERAL PRESENTATION
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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**.

**BREAKDOWN OF SALES**

**BY END MARKET**

- **Automotive**: 21%
- **Logistics**: 12%
- **Metals**: 3%
- **Energy**: 16%
- **Aerospace and industry**: 28%
- **Cement**: 20%

**BY GEOGRAPHICAL AREA**

- **Asia / Oceania**: 37%
- **The Americas**: 17%
- **Europe**: 16%
- **Africa / Middle-East**: 30%

**Figures dated 2017**

- **Order intake**: $3,100 million
- **EBITDA**: $197.7 million
- **Sales**: $2,776 million
- **R&D spent**: $51.1 million
- **Patents in force**: 2,169
- **Patents application relating to energy and environmental performance**: 13%
Fives, an international organization

A WORLDWIDE NETWORK OF SUBSIDIARIES

- 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

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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
1949
PARIS

CANADA
1982
MONTREAL

USA
1996
DENVER

PROVEN TECHNOLOGIES,
WELL POSITIONNED OVER THE AIR POLLUTION CONTROL MARKET

500+
Installed Systems

45+
Countries
MARKETS

WASTE & BIOMASS
Gasification / Syngas Incineration

LIME
Horizontal Kilns Vertical Kilns

CEMENT
Kilns Alkali by-pass Raw mill Finish mill ESP conversions Clinker cooler

ALUMINIUM
Electrolysis Pots Anode Baking Furnace Green Anode Plant Secondary casthouse

OTHER MINERALS
Calciners Process Kilns Furnaces

OTHER INDUSTRIES
Coal Boilers Brick Proppants Steel Iron Ore Pet Coke Glass
Dedusting Solutions

Fives’ dust control solutions consist in proprietary baghouse filters, designed by our engineers to remove particulates out of air or gas generated by from 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

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.
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.
Filtration Process

- 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 particulates emission regulation 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
- Reduce the upgrade costs
- Footprint optimization
- Access to Fives’ large range of after sales services
Dedusting Solutions Efficiency

10K to 2M Nm³/h Treated gas flow

Max 850°C Filtration Temperature

as low as 2 mg/Nm³ Particulate guarantee

0 Water discharge

Options & Safety Features

- ATEX (Explosion proof) Certification
- Completely airtight filter
- Nitrogen pulse cleaning
- Walk-in plenum or penthouse
- NFPA Compliance
Dry-Scrubbing Solutions

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
- Dramatically reduced gas velocity inside the filter
- Longer bag life
- Fives Engineered Sustainability brand

Comparison with benchmark technologies
Optimum balance between compact design and performance

-30% Enhanced bag life
-5% electrical consumption in GTC

-20% HF emissions

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

1. Humidified recycled reagent
2. Hot, dry flue gas
3. Cooled, humidified flue gas
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
---

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, SOₓ, SO₃, HCl, HF, mercury, dioxins/furans, heavy metals, VOCs.
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 + amonia/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

EAD-NOx™ SYSTEM

— EAD™ + catalytic bag filter + amonia/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

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<th>&gt;99%</th>
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<tr>
<td>SO₂ removal efficiency</td>
<td>SO₂ removal efficiency</td>
<td>HCl/HF removal efficiency</td>
<td>NOx removal efficiency</td>
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<tr>
<th>0</th>
<th>10K to 2M</th>
<th>as low as 2</th>
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<tr>
<td>Water discharge</td>
<td>Nm³/h</td>
<td>mg/Nm³</td>
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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

Flexible and compact customized design

Optimized reagent and electrical consumption

High efficiency multi-pollutant control
Other equipment

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)

Services

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

TURNKEY PROJECT MANAGEMENT

— Detailed engineering
— Supply of key process equipment
— Project monitoring
— Installation supervision
— System commissioning
WASTE-TO-ENERGY AND GASIFICATION PROJECTS

- 2017
  EAD™ - OUTOTEC RDF Gasifier - Barry - U.K.
  EAD™ - OUTOTEC RDF Gasifier - Hull - U.K.
  EAD™ - OUTOTEC RDF Gasifier - Boston - U.K.
- 2016
  Hybrid ALL-DRY scrubber - Besançon, FRANCE.
- 1999
  AD™-SONAIR™ - DUNDEE, Kværner, GREAT-BRITAIN.
  AD™ - Chambers County - Simonds, U.S.A.
  AD™ - UPSILON - Be’hai, CHINA.
- 1998
  AD™-TGT® Filter - TPL - Ravenna, ITALIA.
  AD™ - Tersa Montcada, SPAIN.
  AD™ - Issua Gerone, SPAIN.

ALUMINIUM PROJECTS

- 2017
  OZEOS-SONAIR™ - ALBA - Manama, BAHRAIN.
  SONAIR™ - XINFA - Xingyuan, CHINA.
  VIBRAIR-OZEOS - RUSAL - Taishet, RUSSIA.
  SONAIR™- RUSAL - Volgograd, RUSSIA.
- 2014
  SONAIR™ - RTA - Kitimat, CANADA.
- 2013
  SONAIR™ - SGL - Chedde, FRANCE.
  OZEOS - RTA - Jonquiere, Quebec, CANADA.
  TGT-R®-SONAIR™ - MAADEN.
- 2012
  TGT-R® - KAZAKHSTAN ALUMINIUM - Pavlodar, KAZAKHSTAN.
- 2011
  Oxidiser (RCO) - HINDALCO - Aditya, INDIA.
  VIBRAIR - BOGUCHANY - Krasnoyarsk Region, RUSSIA.
  TGT-R® - VEDANTA BALCO - Chhattisgarh State, INDIA.
  Oxidiser (RCO) - HINDALCO - Mahan, INDIA.

CEMENT PROJECTS

- 2017
  TGT® - CIMENT-QUEBEC - St-Basile de Port-Neuf, CANADA.
  TGT® - LIME KILN - CRICKET MOUNTAIN.
- 2016
  TGT® - LIME KILN - CRICKET MOUNTAIN - Pilot Peek, USA.
- 2015
  TGT® - ARMSTRONG CEMENT - Cabot, USA.
- 2012
  SONAIR™ - ROANOKE CEMENT - Roanoke, U.S.A.
  Conditioning Tower - ASH GROVE CEMENT - Leamington, U.S.A.
- 2009
  TGT® - CEMEX BALCONES - New-Braunfels, USA.
  TGT® - LEIGH EDMONTON - Edmonton, CANADA.
  TGT® - ST-LAWRENCE CEMENT - Missisauga, CANADA.

MINERAL AND OTHER PROJECTS

- 2015
  EAD™-TGT® - ST-GOBAIN - Bryant, USA.
- 2011
  EAD™-TGT® - ST-GOBAIN - Fort Smith, USA.
- 2007
  EAD™-TGT® - VIGRINIA TECH - Blacksburg, USA.
- 2006
  EAD™-SONAIR™ - GENERAL SHALE 2 - Fairdale, USA.
- 2003
  AD™-SONAIR™ - BORAL BRICK - Augusta, USA.
- 2002
  EAD™-TGT® - REDLAND BRICK - Pittsburgh, USA.
- 2001
  SONAIR™ - RÉGIE RIVE-SUD QUEBEC - Lévis, CANADA.
A worldwide presence

fives
ultimate machines
ultimate factory

Fives Solios Inc
625, President Kennedy Avenue
14th floor
Montreal (Quebec) H3A 1K2 - CANADA
Tel.: +1 514 284 0341 - Fax: +1 514 284 1326

Fives Solios
66 route de Sartrouville
Parc les Erables - Bât 4
78230 Le Pecq - FRANCE
Tel.: +33 1 30 87 45 50 - Fax: +33 1 30 87 45 55

Fives Solios Corp
625, President Kennedy Avenue
6860 S. Yosemite Ct.
Suite 2204
Centennial, CO 80112 - UNITED STATES
Tel.: +1 303 713 0222

fsi.airpollutioncontrol@fivesgroup.com