Volodyne

Vortex SSPC

Super Sonic Poloidal Cleaning

Scott Baumann
Volodyne Co-Founder



Vortex SSPC

Objectives

- → ***Increase Safety: Personnel & Equipment***
- → ***Eliminate Soot Blowers & Rappers: Collateral Damage***
- → ***Increase Online Production / Increase Fuel Through-Put***
- → ***Eliminate Online Explosive Cleaning or Water Washing***
- → ***Eliminate Forced Outages for Boiler Cleaning***
- → ***Substantially Reduce Scheduled Outage Cleaning***
- → ***Increase Boiler Efficiency – Reduce CO_2 Footprint***

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the Team



→ **Sootblower engineers:**

- ***Sootblower design & application of traditional and advanced sootblower technologies:***
- ***ISB, Strain Gauges, Variable Flow & Pressure Control, Water lances, LP steam blowing, ShowerClean, Water Cannons, Shock & Pulse Devices***

→ **Boiler OEM engineers:**

- ***Heat transfer optimization***
- ***Boiler pressure part integrity***

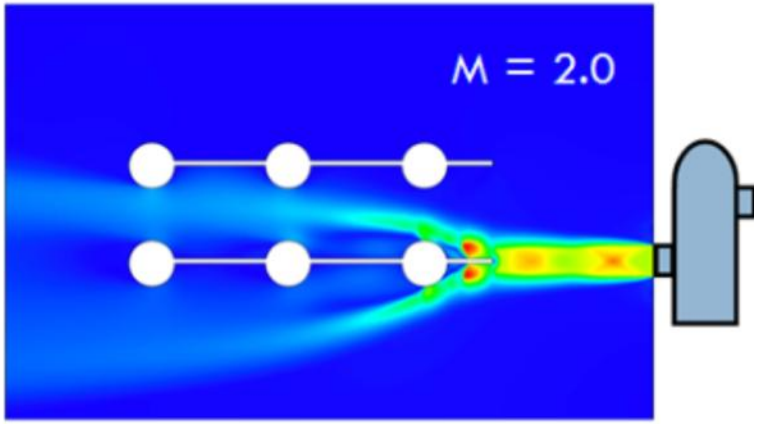




→ **Technical Oversight & Heritage:**

- **University of Sarajevo & Delft University of Technology**

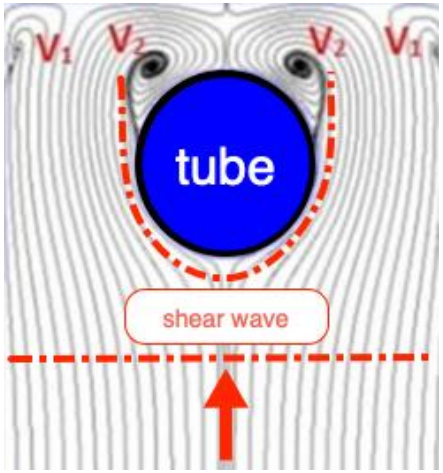
Vortex SSPC : Technology Comparison



Sootblower Steam jet:

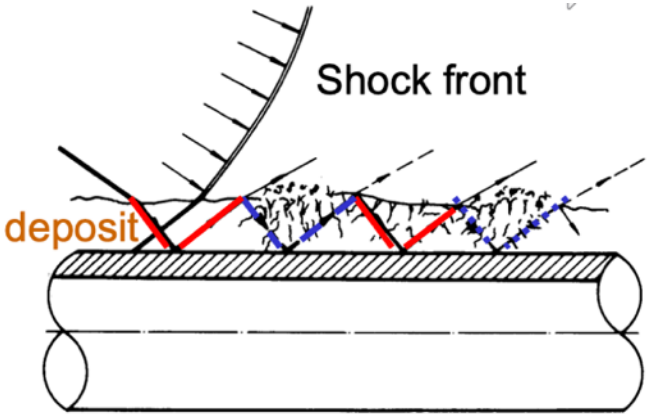
- Cannot remove deposits from tube to tube
- Accelerates ash to sonic velocity = erosion
- Steam = H_2O = ash agglomeration

VS.



Shock / Shear waves:

Envelope tubes fully, reform and strike tubes
In succession: deep 360 deg cleaning



- shock wave penetrate the deposits and reflect among the tube walls
- reflection from free surface
  - ➔ rarefaction wave
  - ➔ loosening and destruction
- Interchange of compression and tensile stresses weakens and removes ash

Vortex SSPC: *Reliability & Safety*



Extremely long maintenance interval or Volodyne LTSA

Extremely low OPEX: single fuel & plant compressed air

Shock wave fully formed inside SSPC: *no moving parts*

No inertia = no vibration imposed on boiler mounting

No disruption of gas path = no vibration of boiler tubes

Proven zero effect on uncured or degraded refractory

HMI interface allows full operator control over process

Operational noise level = 84 dBA

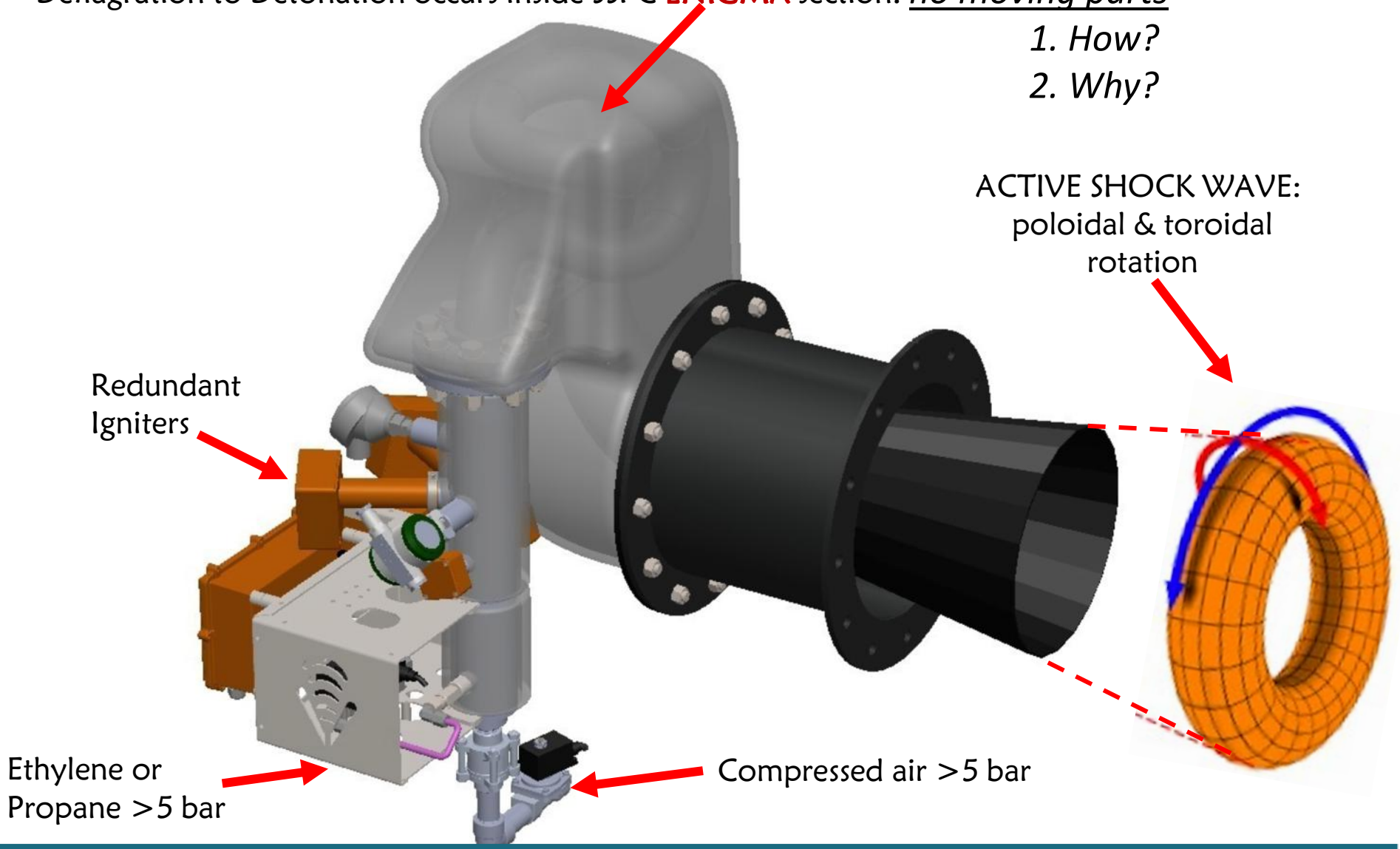
Vortex SSPC: Functional Overview

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Deflagration to Detonation occurs inside SSPC **ENIGMA** section: *no moving parts*

1. How?

2. Why?



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O&M Safety and Risk Aspects

Vortex SSPC: safe boiler cleaning

- ✓ No steam & no condensate
- ✓ No membrane wall impact
- ✓ No refractory degradation
- ✓ No mounting vibration or stresses
- ✓ No shaking pressure parts
- ✓ No gas path upsets
- ✓ No moving parts



Vortex SSPC: integral safety systems

- ✓ Fuel leak detection
- ✓ Redundant fuel isolation & ignition systems
- ✓ Purge cycles: start/stop/failed ignition
- ✓ 100% injector integrity test
- ✓ Ignition validation @ each pulse
- ✓ Shock pulse intensity measurement & control
- ✓ Plant DCS permissive to operate

Substantial reduction in maintenance needs = Substantial reduction in personnel exposure

Vortex SSPC

Performance Improvements & Expectations: Solid Fuel

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On-Load Deep Clean Superheater, Generating Bank & Eco

- Maximize available heat transfer surface
- Restore healthy gas path velocities
- Reduce or eliminate soot blower erosion
- Reduce or eliminate under ash corrosion

Reduce or eliminate soot blower steam consumption

Reduce or eliminate soot blower / rapper O&M costs

Reduce boiler exit gas temperature

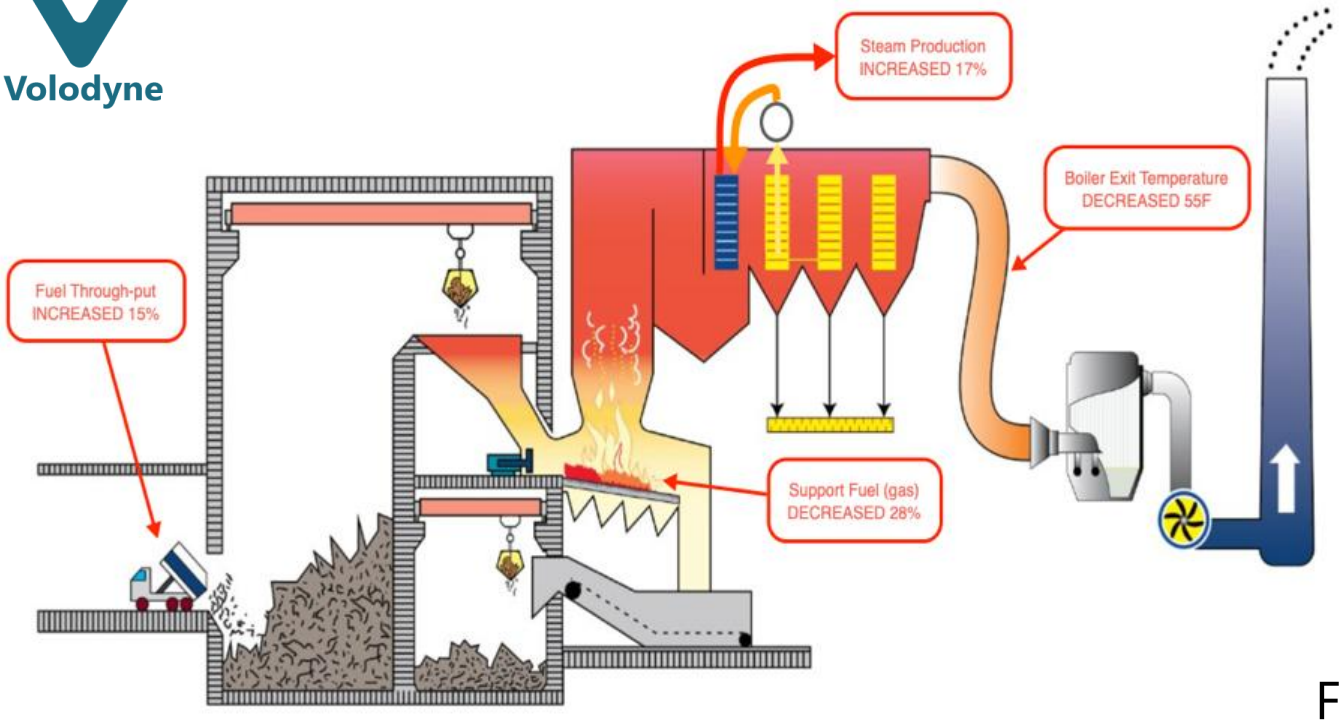
Reduce ID fan amperage

Substantially reduce outage cleaning

Increase fuel through-put ≈ improved heat rate

SCR catalyst and LPA ash reduction

Vortex SSPC Value: *Increased Production*



SSPC:
Superheaters
Economizers

60K TPY MASS BURN FACILITY

(Minnesota, USA)

- OLC ELIMINATED 100%
- SOOTBLOWERS ELIMINATED
- CLEANING OUTAGES ELIMINATED
- OUTAGE CLEANING ELIMINATED
- FUEL THROUGHPUT INCREASE = 15%
- STEAM CAPACITY INCREASE = 17%

Financial
Performance Metrics:
Year 1: $1.5M
Year 2: $1.7M
Year 3: $1.6M
Year 4: $1.55M
TOTAL OPEX TO DATE:
$10,400 (FUEL)
TOTAL MAINT COSTS: $600

Plant manager quote:
"THE VORTEX SSPCs ARE THE BEST INVESTEMENT WE HAVE EVER MADE"

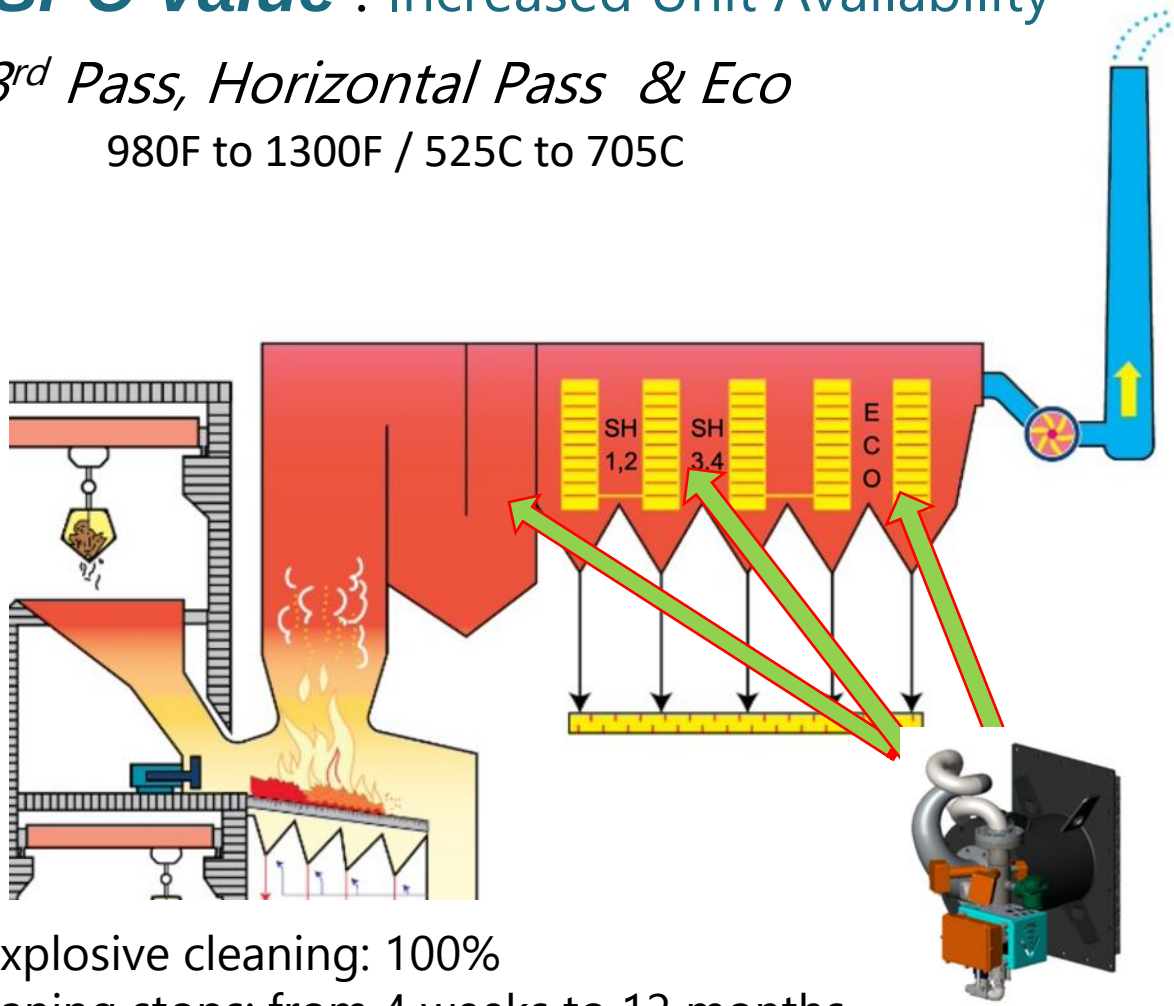
Vortex SSPC Value : Increased Unit Availability

3rd Pass, Horizontal Pass & Eco

980F to 1300F / 525C to 705C



190K TPY Facility
Michigan, USA



1. Eliminated online explosive cleaning: 100%
2. Extended boiler cleaning stops: from 4 weeks to 12 months
3. Daily shock pulses delivered by 6 SSPCs (3 per line): 5,760
4. Total annual OPEX costs: $2,600 (FUEL) / Maint EXP: $0 *(Volodyne LTSA)*
5. Next Steps: Supplement 6x additional SSPCs for maximized deep cleaning

Plant manager quote:

"VORTEX ARE LIKE METH FOR THE BOILER – USE THEM ONCE AND YOU CAN'T LIVE WITHOUT THEM"

Vortex SSPC: *Performance Matters*

High Fouling WTE Superheater @ 593-649C / 1100-1200F

Volodyne



Typical: 5 Months To Plugged SH







Vortex Gen 1 Installed @ 3 months into run

Vortex SSPC: Performance Matters

High Fouling WTE Superheater

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Waste to Energy: On-Load Superheater Cleaning
Gas Path: heavily fouled 1100-1200F (593-649C)









7 WEEKS

Before: *normal fouling*
- heavy fouling @ 3 months
- Vortex SSPC installed
- all deposits left as-found

After 7 weeks Vortex cleaning:
- ash hopper plugging eliminated
- superheater ash deposits eliminated
- outperformed (4) sootblowers

Vortex SSPC Value : High Fouling WTE Economizer

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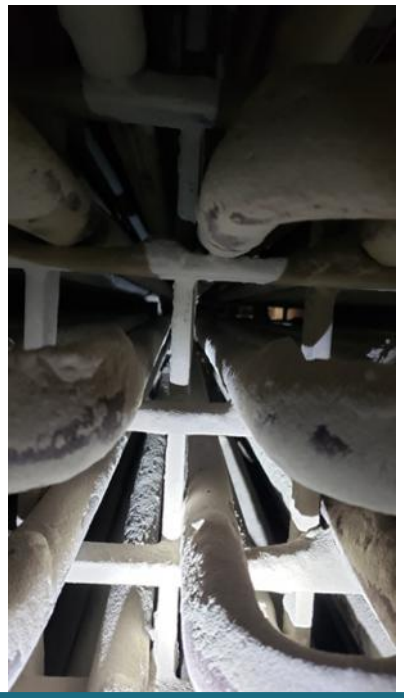
History: fully plugged @ 4 months
1 to 2 days explosive cleaning + 30hrs manual

- (3) Vortex cleaners installed
- 15 pulses @ 5 hour interval
- (3+) years OPEX = $3,500

12 MONTH OUTAGE INSPECTION:
NO ASH TO REMOVE "ECO IS CLEAN"



5m opposite SSPC Position



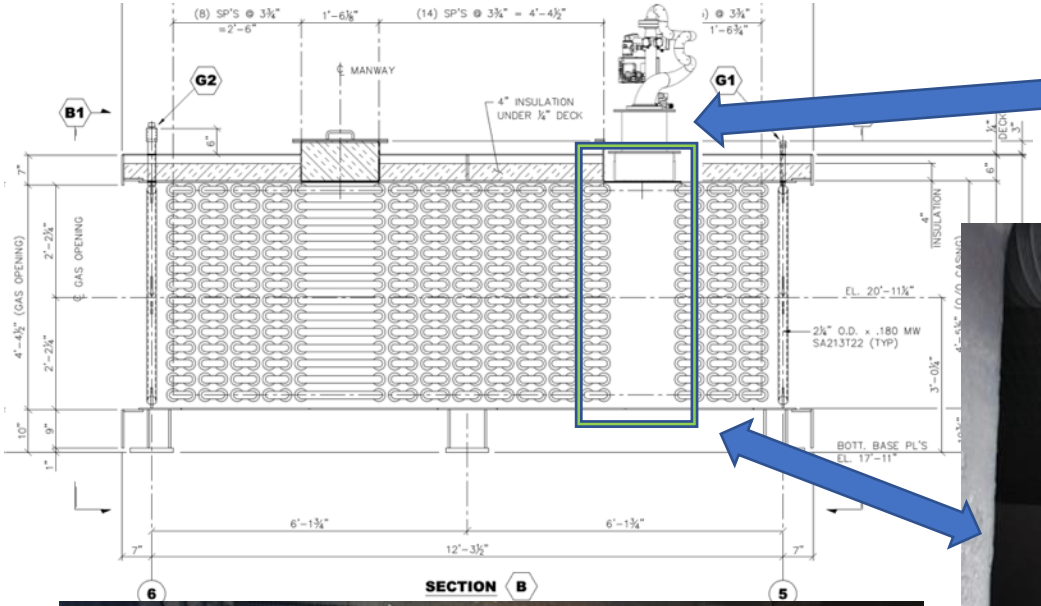




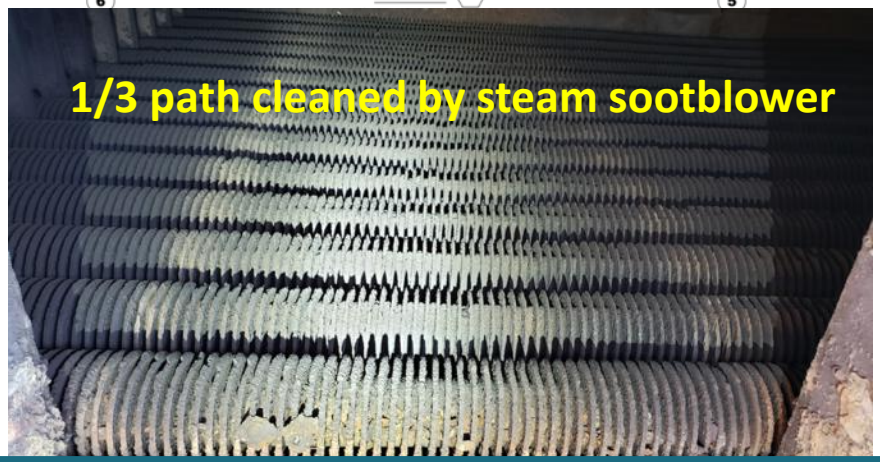
Vortex SSPC

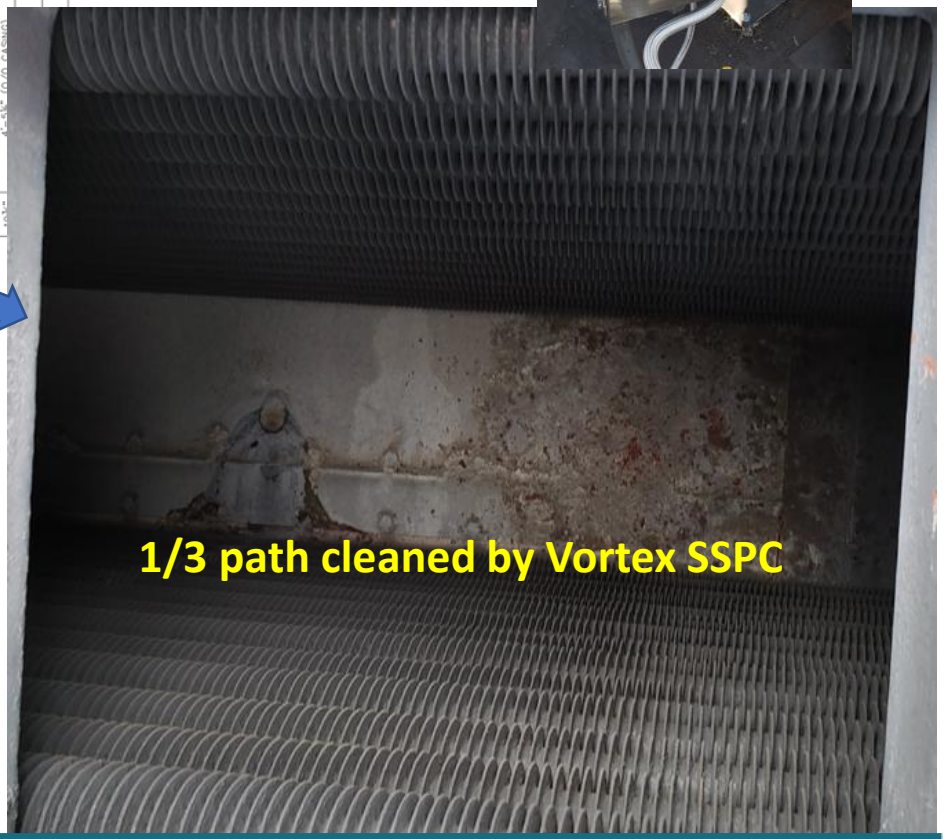
Finned Tube Economizer

(6 + 12 months operation inspection)







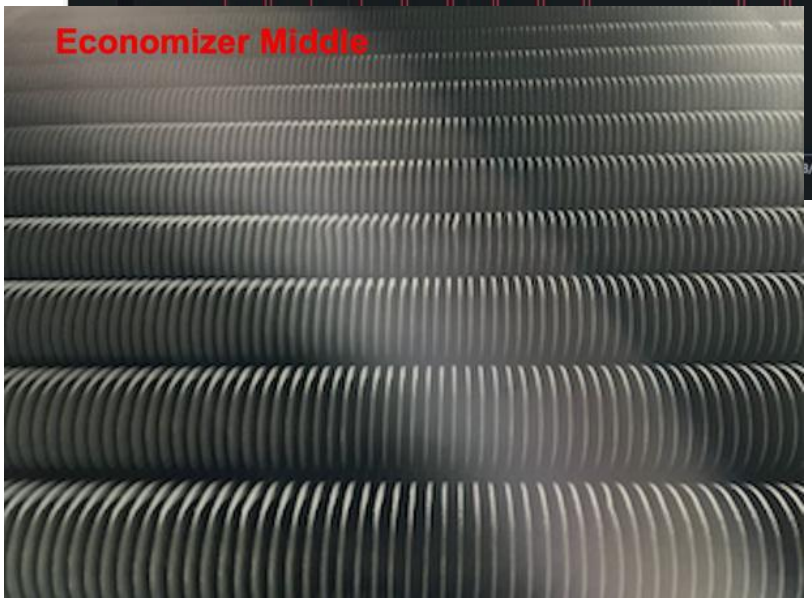


Vortex SSPC:

Remote Performance Monitoring

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(3) SSPCs @ 20 months

SH, Evaporator & Eco

1,502,500 shock pulses delivered

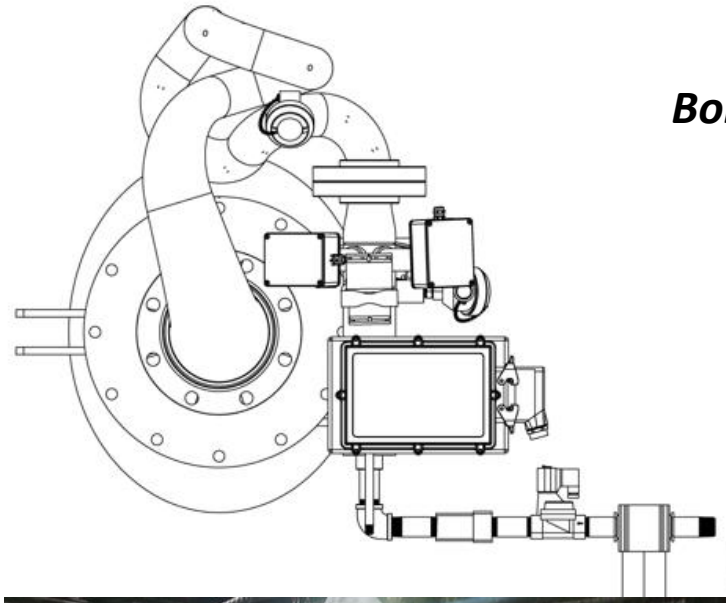
Total OPEX: $5,600

Total Maintenance EXP: $0 (Volodyne LTSA)

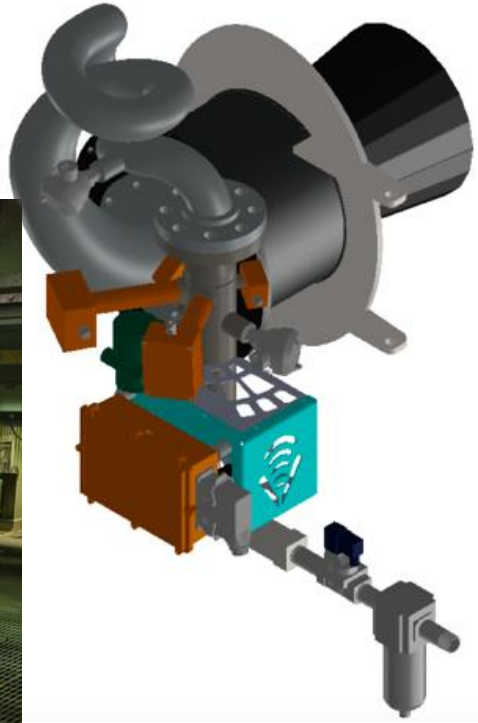
Vortex SSPC

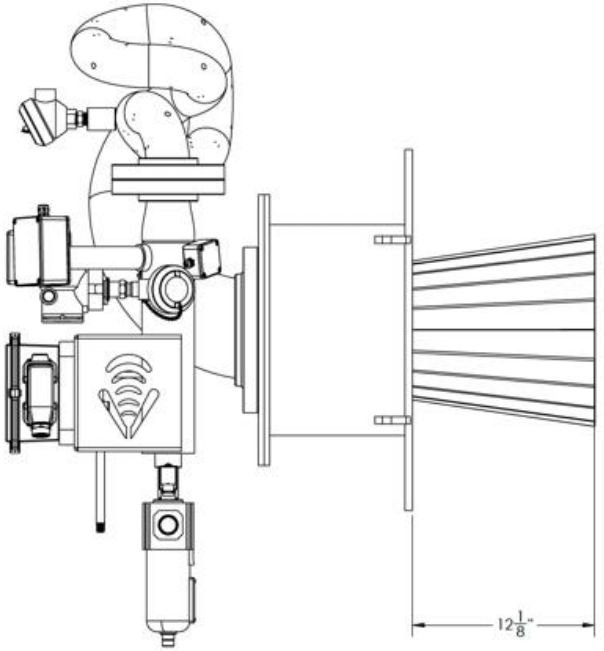
Installation Examples: Oval Access Door

Boiler Access Door Mounting









NOTE: PENETRATION, SHOULD EXTEND NOZZLE 1" BEYOND REFRACTORY.

Vortex SSPC Kraft Recovery Boiler Installation

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HMI Controller & Fuel/Air Station

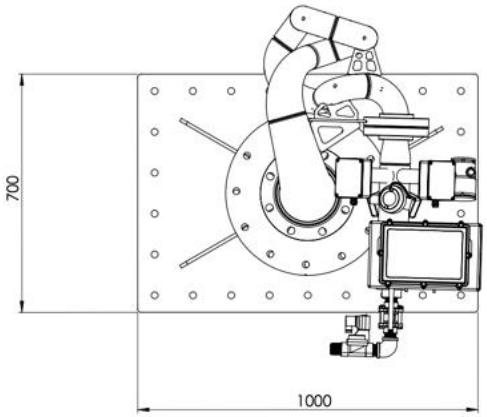


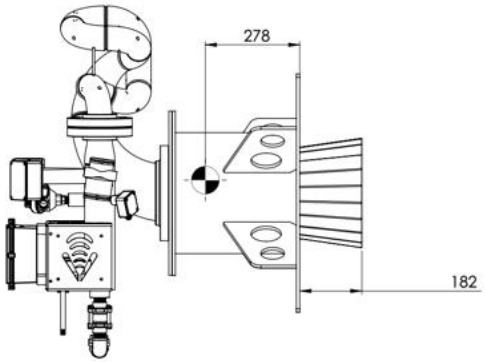


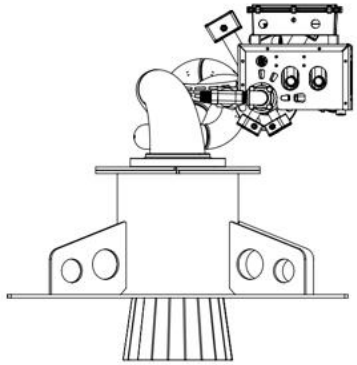
Vortex SSPC installation (boiler online)
- Very compact
- Easily handled & supported

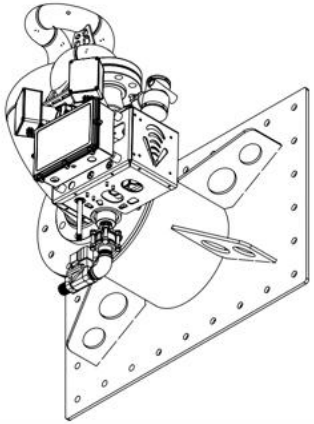
Vortex SSPC

Installation Mounting Examples:









Insulated Steel Duct / Wall Mount



Membrane Wall Mount

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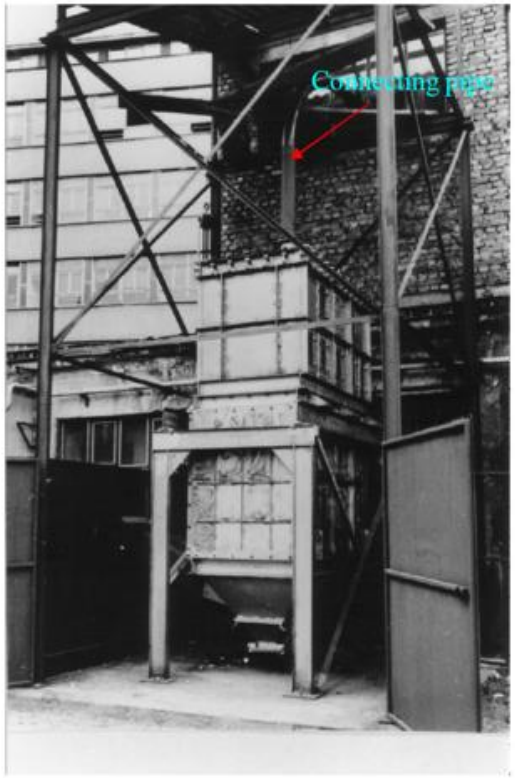
Vortex SSPC: Technology Background

Pioneer Development

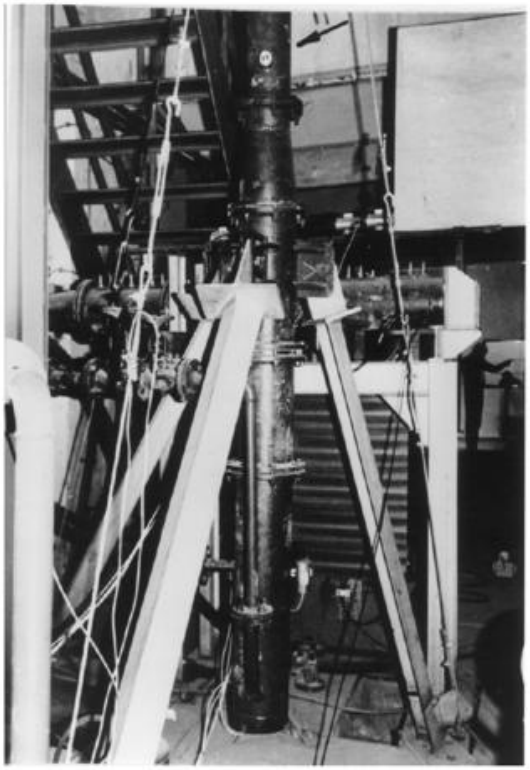
Power Plant "Kakanj" near Sarajevo, BiH



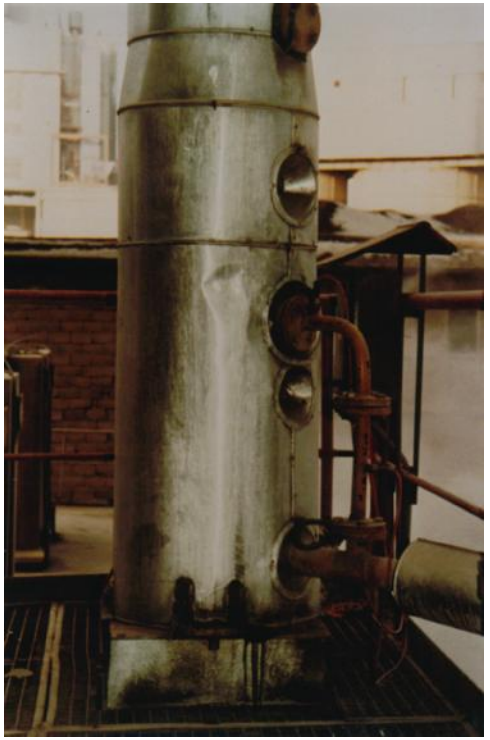
Laboratory experiments, since 1982



Outlook of the experimental Boiler furnace



A view at the laboratory detonation chamber



One of (3) original D W G Units

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Vortex SSPC: Pioneer: Kemal Hanjalic

