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WESP VS. DRY ESP

The use of the wet electrostatic precipitator (WESP) for collection of fine particles is rapidly increasing every year for the past 40 years. The major reason for this is that the air pollution codes on solid particulates PM 2.5 and condensable (e.g., organic droplets),Acid mist and Toxic heavy metals are becoming more and more stringent and they are being enforced to a much greater extent than just a few years ago. Traditionally the high energy scrubbers, dry electrostatic precipitator and fabric filters have been applied to control of fine particles. However, the high energy scrubber has extremely high energy consumption (see Chart, Appendix A) which in some cases is impossible to sustain especially for large gas volume for Power Boilers. The dry electrostatic precipitator has dust resistivity limitations which have to be considered. The fabric filter, especially the high energy fabric filter (e.g., pulse jet) gives inherently very high removal efficiency on fine particles; however its application is limited by the chemical and physical nature of the particles. If they are hydroscopic and/or have a tendency to solidify on the filter bags, or are wet and thereby stick to the fibers, the fabric filter cannot be used. There are also definite temperature and chemical resistance limitations associated with the fabric filters and normally the fabric filter will not remove gaseous pollutants or uncondensed organic vapors, unless it combined with dry scrubbers which are complicating disposal of the waste. (See Appendix C)

The wet electrostatic precipitator (WESP) overcomes many of the limitations of the high energy scrubber, dry electrostatic precipitator, and the fabric filter. It has a relatively low power consumption, typically for a WESP comprised of one electrical field, and pre scrubbing section, the total power consumption including fan, pumps, power supplies and insulator heaters would be 1.6 kw/1000 acfm; this would be equivalent to a scrubber pressure drop of only 5.8 in water gauge (W.G.) with a liquid to gas ratio of 5 gpm/1000 acfm. According to the EPA (see Chart Appendix B) wet scrubber with pressure drop at 5.8" W.C. is capable of removing particles below 1 micron with efficiency less than 40% comparing to the WESP with efficiency of 99 %. Direct savings when customer would replace old Venturi with our WESP can be estimated by using the energy cost comparison chart (Appendix A).

The WESP that is installed after the FGD Scrubber also operating as an electrostatic mist eliminator which is much more effective than a mechanical type with chevrons or spin vanes that are normally used with scrubbers, in fact WESP can remove liquid droplets as small as 0.1 micron comparing to mechanical type that are limited to 15 microns.

When comparing the WESP with fabric filters, the WESP performance is not much affected by the nature of the particles. For example, it will remove the organic fraction that has condensed at the WESP operating temperature which is always the saturation temperature of the gas that is being treated.

It follows, therefore, that the performance of the WESP is not very sensitive to the gas temperature, since the gas to be treated must be saturated with water vapor before it enters the electrostatic field. Further, since the internal components are continuously being washed with water or process liquor, the WESP will also remove gaseous pollutants only limited by the solubility of the gaseous component in the washing liquor.

The dry electrostatic precipitator performs well only when the dust deposit on the grounded collecting plates has a resistivity greater than approximately 10^7 ohm-cm, but less than $2x10^{10}$ ohm-cm[1]. If the resistivity is less than 10^7, the electrostatic force holding the dust particles on the dust layer or plates is very low and the reentrainment of particles can become a serious problem during steady operation and during plate and electrode cleaning (e.g., rapping). This will have the overall effect of lowering the collection efficiency. If, on the other hand, the dust layer resistivity is higher than $2x10^{10}$ ohm-cm, the voltage drop through the dust layer to the grounded plates can become significant, having the effect of lowering the field strength in the space between the ion emission electrodes and the top of the dust layer. This can cause a breakdown in the field and so-called "back corona" can take place. Both of these effects will dramatically lower the collection efficiency of the Dry ESP.

Since the collecting tubes and electrodes in our WESP are cleaned continuously by the fine water mist droplets deposited on collecting walls together with solid particles, the above mentioned limitations do not exist. The resistivity of the water film, which is very low, is the governing factor in the dust discharging process, not the resistivity of a dust layer formed by the collected particles.

The Patented and Proprietary design of EnviroEnergy WESP has the following distinctive features:

- **Two times larger Collection Area in the same size housing and discharge spacing**
- **Three times more density of Corona Current evenly distributed across the gas flow**
- **Rigid Ionizing Electrodes with self-sharpening ionizing needles**
- **Maintenance free Insulator compartments with double protection from moisture**
- **Many others fabrication methods protected by our trade secrets**

It therefore follows that the wet electrostatic precipitator on certain applications has many technical and economic advantages (See Appendix D) when compared to high energy scrubbers, fabric filters and dry electrostatic precipitators. Its use can be generalized to applications where particles to be removed are solids and/or condensable, with a significant submicron (PM 2.5 and H_2SO_4) range, and where gaseous pollutants (SO_X, NO_X) also must be removed by the low energy Scrubber upstream of the WESP that can be located in the same housing.

Over last 100 years WESP was used with high degree of success in the USA and around world especially in Japan in the following industries:

- Chemical (sulfuric and other acids)
- Metallurgical
- Coal and Oil fired Power Plants
- Incinerators and Waste to Energy installations
- Textile and Carpet
- Pulp and paper and many others

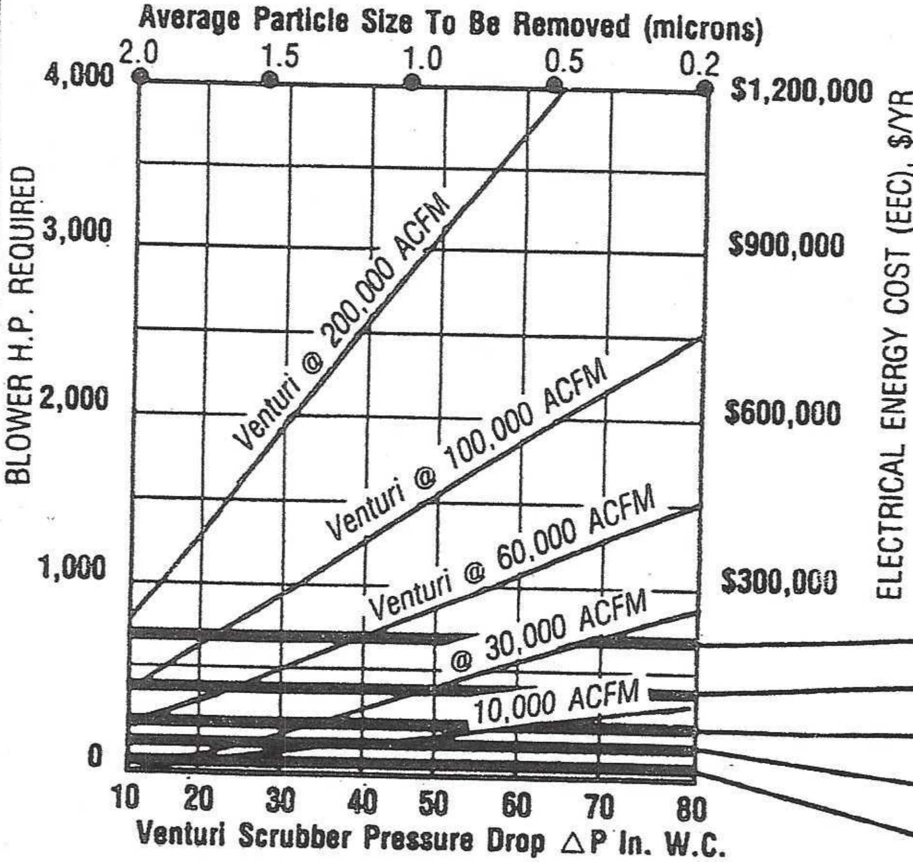
Dr. Isaac Ray

APPENDIX A

Energy Cost Comparison Between Venturi Scrubbers and Enviroenergy Wet Electrostatic Precipitators (WESP)

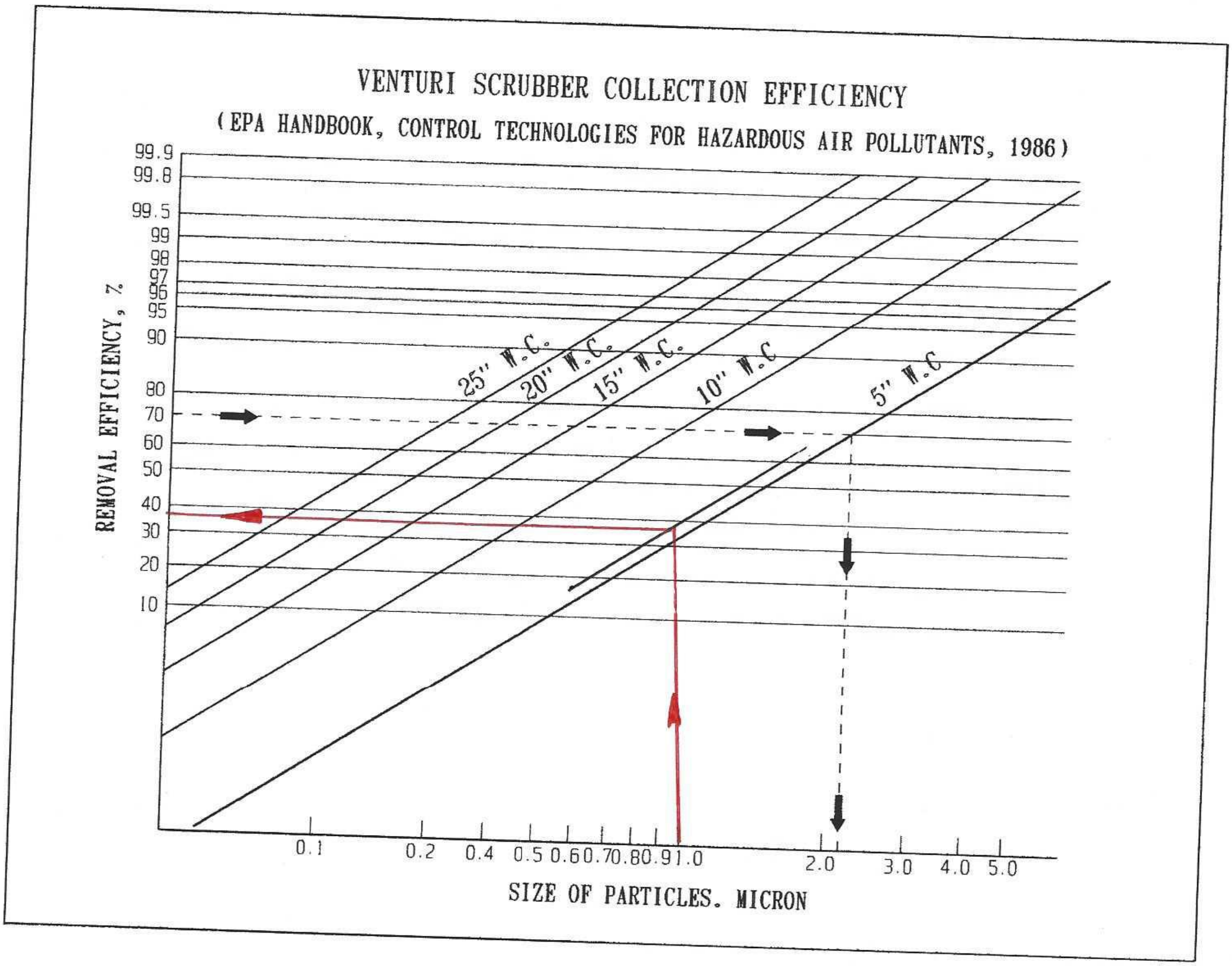
This graph is based on the following:
1) Δ P values for venturi based on EPA/625/6-86/014 handbook
2) Removal Efficiency.......95% (*)
3) Operating Time............8,000 Hrs/Year
4) Electrical Energy Cost...5¢/KWH

(*) For efficiency of 99% the energy cost for venturi on the graph multiple by 1.43. For Enviroenergy WET ESP the energy cost remains the same.



WET ESP	
Saturated Gas Flow ACFM	EEC, $/Yr
200,000	172,600
100,000	86,300
60,000	51,780
30,000	25,890
10,000	8,600

APPENDIX B



VENTURI SCRUBBER COLLECTION EFFICIENCY
(EPA HANDBOOK, CONTROL TECHNOLOGIES FOR HAZARDOUS AIR POLLUTANTS, 1986)
REMOVAL EFFICIENCY, %
99.9
99.8
99.5
99
98
97
96
95
90
80
70
60
50
40
30
20
10
25" W.C.
20" W.C.
15" W.C.
10" W.C
5" W.C
0.1
0.2
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2.0
3.0
4.0
5.0
SIZE OF PARTICLES. MICRON

APPENDIX C

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COMPARISON OF TECHNOLOGIES

Baghouse Technology

- Requires 10" w.g. pressure drop and hence bigger blowers & higher operating power cost
- Made of Carbon steel, susceptible to corrosion and short life
- Contains fabric bags prone to cause fire with presence of carbon injected for VOC's removal
- Requires large, complex and dust prone lime slurry system with moving parts and low mechanical reliability
- Limited S02 removal capability for inlet gas temperature below 600 degrees Fahrenheit
- Cannot remove hydrocarbon fumes without injection of coke/carbon since they are in the vapor state
- Higher oil loading or Hydrocarbon concentration requires more coke injection, causing disposal problem, pressure drop problem, bag blinding problem
- Initial equipment cost lower
- Requires bag replacement every two (2) years, incurring down time and high operating cost
- High operating cost and total evaluated cost over 5 years is much higher

ENVIROENERGY
Wet Electrostatic Precipitator

- Requires only 1" w.g. pressure drop and low energy consumption
- Made of Stainless Steel 316L providing over 25 years life
- Contains no fabric. All items are solid steel, creating no danger of any fire
- Uses compact 50% caustic, delivered in ready form, all enclosed
- Inlet temperature has no bearing on S02 removal efficiency
- Condensing Wet ESP design attains high hydrocarbon removal efficiency
- Higher oil loading requires no additional chemical; in fact higher oil loading creates a coating of oil on the ESP tubes, thus minimizing any potential corrosion and buildup
- Initial equipment cost only 20% higher
- Minimal replacement parts. Minimal downtime. Nothing to replace.
- Low operating cost. Low total evaluated cost over 5 years.

APPENDIX D

10 Reasons To Buy A Wet Electrostatic Precipitator

1. TECHNOLOGICAL - ESP's are the only air pollution control device that use electrical energy to clean the air. All other technologies use mechanical means, i.e., baghouse, scrubber, fiber bed mist eliminator. Solid or liquid sub-micron particulate, heavy metals, dioxins, furans and mercury are too small to be removed by mechanical forces. Only electrostatic precipitators can capture these pollutants efficiently. By simply charging the particulate with negative ions from an ionizing electrode, the sub-micron particulate is attracted to a positively charged collecting surface and removed from the gas stream.

2. ECONOMICAL - WESP's use less energy than mechanical collection devices. WESP's apply the electrical energy used only to the particulate matter in the gas stream without restricting airflow. Mechanical air pollution control devices expend energy on the gas flow by restricting it, thus increasing the size of the blower. A typical 30,000 CFM baghouse requires a 100-HP blower while a WESP needs only a 11-HP blower. WESP's maintenance costs are lower and production downtime minimized..

3. PERFORMANCE - WESP's are the only air pollution control technology that can guarantee high particulate removal efficiency continuously, regardless of changes or upsets. Enviroenergy WESP's can attain 99.9% removal efficiency and zero opacity for virtually all gas flow conditions or process chemistry. Baghouses can remove only dry, solid particles. Any oil vapors in the gas stream pass through the bags and create condensed oil mist with opacity up to 80%.

4. RELIABILITY - WESP's have no moving parts to wear. Enviroenergy WESP's utilize a solid stainless steel bar as its ionizing electrode which is unbreakable. Unlike baghouses that clog and/or leak and have to be replaced. WESP's never have to be replaced.

5. SELF-CLEANING - Enviroenergy proprietary design uses a thin film of condensed water on the entire length of the collecting surface to continuously wash away particulate accumulation.

6. ZERO-LIQUID DISCHARGE ENVIROENERGY can design your WESP system to use recycled water. By employing complete evaporation at the bleed and return of clean condensate back to the system, we can guarantee zero discharge of water.

7. FIRE PROTECTION - WESP's are inherently safer to operate than baghouses because they are "wet" systems. This acts as a firewall to prevent fire from traveling farther downstream. The WESP itself is encased in a water cooled jacket with condensed water on the inside of the walls.

8. LOWER NOISE LEVELS - Because a WESP can use a small fan rather than a large pressure blower, there is less noise. Where installation is inside a building this means a quieter environment. Insulation and soundproofing are not needed to run a WESP.

9. HEALTH - Toxic sub-micron particles have been found to be a leading cause of cancer. One gram of 0.1 micron particle has 10 times the surface area as one gram of a 1 micron particle, thus being 10 times more deadly. Mechanical means of entrapment are unsuccessful at these sub-micron levels.

10. MEET FUTURE EPA STANDARDS - In today's world of ever increasing regulation of industry, only WESP technology can guarantee future air pollution control standards. Why buy a system today that may be obsolete in a few years when a WESP can guarantee meeting pratically all future requirements? Enviroenergy can guarantee 0% opacity and 99.9% removal efficiency.

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Gas cleaning Equipment and Consulting since 1983

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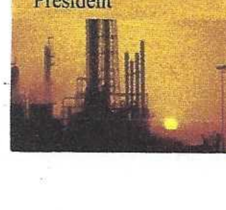
President



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