

New Technology Can Drastically Reduce Global Warming

by:

Gary Berwick, P. Eng.
Quality Air Management Corp.
Waterloo, Ontario, Canada

Emission Sources

For the last twenty years, more and more pulse jet continuous cleaning dust collectors have been installed on particulate producing industrial processes. As the earth's population increases, the demand for energy continues to grow at a rapid rate. The demand for electricity, to power our society, comes largely from fossil fueled power generating stations. These dust collectors have much higher collection efficiency when compared to the mechanical collectors, which were applied to combustion processes up to 60 or 70 years ago. In spite of the improvement in collection efficiency which has risen from 90% to over 98% with these jet cleaning units, recent satellite photos of the planet show a large swath, much like a black cloud, covering more than 70% of the planet's atmosphere. More and more scientists believe it is the major cause of "global warming". The push is to reduce particulate emissions coming from these dust collectors, whether they be new or existing installations.

New Solutions

New advanced technology in the design and operation of dust collectors allow the penetration of solid particulates to be reduced by over 95%. This technology developed over 25 years ago in the Midwest United States is now available to all the industrial countries in the world at affordable cost. The good news is that this new technology for particulate collection systems costs 30% to 40% less in both initial acquisition costs and long term operating cost. In addition, this technology can be used to modify existing collectors and the rebuild costs have a payback of less than two years. The technique is simple, quick to implement and risk free.

History of the Development of Jet Cleaning Dust Collectors

It is important to understand the evolution of dust collector designs.

The first jet cleaning collectors were "blow ring collectors" often referred to as the "Hersey" patented design. Figure 1 below illustrates its operation. In this design a movable donut shaped ring with holes on the inside of the ring travels over the outside of each bag. The bags were 12 to 30 inches in diameter. The dust entered the inside of the bags and collected on the inner surface of the cylinder(s). The original designs consisted of a single bag extending through to one or more floors in a factory. It might take several minutes for the blow ring to complete its travel. Felted bag media was always the material of construction. These collectors were used on recirculation systems where the particulate emissions coming through the bags were low enough to be returned to the work environment. There were two fans one to propel the dusty air inside the bags and a cleaning fan which was fed with a flexible duct that allowed movement of the ring throughout the length of the bags. The penetration of particulate at the outlet through these cylindrical bags was 0.000025 grains per cubic foot. The inlet loads were typically 5-10 grains per cubic foot. These emission levels were similar to outlet emissions from mechanical shaker collectors with woven filter bags. The pressure drop across these collectors was 0.5 to 1.5 inches of water column. The filtering ratio defined as the flow in feet per minute per square foot of filter area was usually 18 to 24 FPM.

Next was the development of dust collectors that cleaned with pulse jets instead of blow rings. Pulverizing Machinery needed to have a collector capable of collecting over 250 grains per cubic foot. The blow ring collector cleaning system was not fast enough without going to multiple bag units and high "blow ring" speeds which required high maintenance costs.

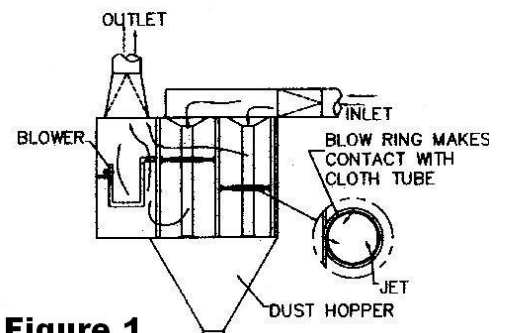


Figure 1

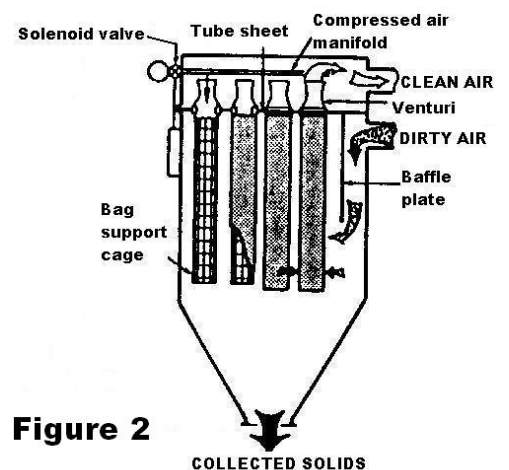


Figure 2

The requirements of the design were to package more filter cloth in a cube and to clean large areas of filter cloth quickly. This arrangement is illustrated in Figure 2. Designers discovered that cleaning occurred within 120 milliseconds of the jet induced by the compressed air entering the filter bags.

Impact of Design Changes

The velocity of the cleaning jet went up over 24,000 feet per minute. This is related to the velocity of the dust ejected from the bag during the cleaning pulse. Therefore, the dust was directed toward the adjoining rows of bags in the filtering mode. Suddenly pressure drops doubled and even tripled from the previous 6 foot long bag designs. Compressed air consumption went up by the same proportion. Filter life went down by 65% to 75%.

The reaction of the specifying engineers was to lower the filter ratio to get bag life to last 24 months on many processes. More original and replacement filter elements were sold and the costs of pollution control pulse jet collectors doubled and tripled. The reason for this dramatic change is illustrated in Figure 3. During the cleaning cycle the dust is ejected from the filter surfaces at a speed proportional to the cleaning jet velocity entering the filter bag. This dust is propelled toward the adjoining rows of bags in the filtering mode. With higher density dusts, the dust is driven through the filter cake and media to the exhaust plenum. The cake starts to lose permeability in limiting the penetration. In the process, it substantially reduces its dust holding capacity of the filter bags between cleanings. The result is that a much larger quantity of dust penetrates to the clean air side. The additional effects are more frequent cleaning and higher pressure drop as well as decreased bag life.

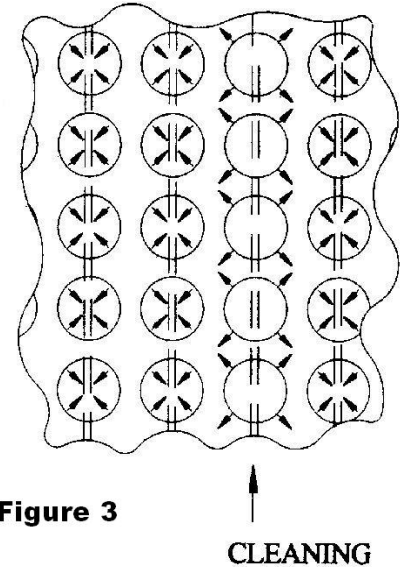


Figure 3

Satellite Photos

Satellite photos reveal a vast black area covering our planet from fossil fuel fired boilers for power generating stations and other combustion processes. Most scientists in this field declare it is the major cause of global warming with its many harmful effects.

The Solution Lies In Improving Dust Collector Efficiency By Applying A New Proven Advanced Technology

Solution 1; Pleated filter elements

Figure 4 shows a continuous cleaning pulse jet collector with pleated filter elements. This arrangement eliminates the main cause of particulate penetration through the collectors, which is dust being propelled from the filter element in the cleaning mode to an adjoining filter in the filtering mode. The dust is propelled from the filter surface towards another filter surface that is also pressurized by the cleaning jet. No dust can penetrate through the filter and its associated filter cake. These collectors were introduced to the market in 1972, and now dominate the low temperature dust collection market. Their limitations are that they are sometimes unreliable in processes where the dust load is uneven or when the process involves higher temperatures and wide swings in humidity. However, the particulate penetration is at the same level as the 'blow ring' collectors, typically 0.000025 grains per cubic foot a reduction of more than 95% compared to the conventionally designed pulse jet collectors with the high velocity jets.

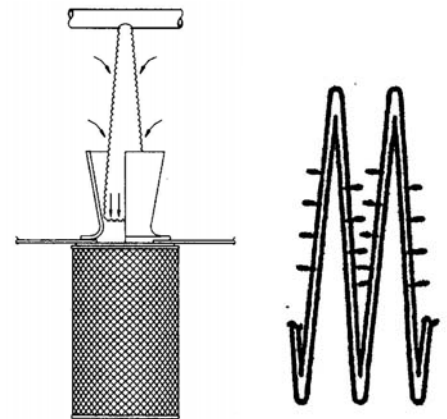


Figure 4

Solution 2; Fabric Media Changes

Many new fabric media have been introduced. Their effectiveness depends on their ability to stop the penetration of dust from high speed jet cleaning systems to the rows of adjoining bags in the filtering mode. Some of these newly developed medias are:

- 1) Heavier felted weights; 24 oz media, when substituted for 14 oz. media reduces emissions by 30-40%.
- 2) Variable density felts; where much finer denier was placed on the filtering surface and coarser threads underneath. This also reduces particulate penetration by 30-40%.
- 3) Laminated film bonded to the surface of conventional cloth filters. It was originally developed for rain wear, to prevent liquid water droplets from coming through the cloth yet allowing it to breathe and release water vapor. This film forms a barrier to the dust striking the surface of the filter element. It also reduces emissions through filters, even with a high speed cleaning jet. The pressure drop increases through the filter element and it has a limited dust holding capacity. So, energy requirements are about the same as conventional collectors. It reduced dust penetration by over 95%. However it is relatively expensive because the filter permeability is reduced, limiting the filtering ratio and obliging designers to double number of bags in a collector. The manufacturing process is more costly in laminating to a filter element, compared to conventional filter media.

Solution 3; Advanced Technology Pulse Jet Designs

In 1978, a new cleaning design for fabric filter elements was patented and applied to a wide range of dust collection including combustion processes. It allowed the collectors to operate at high filter ratios and low pressure drops as similar to the "blow ring" collector. The emission rates were reduced by over 90% compared to the high speed jet designs. These collectors were around 50% smaller in size, ran at pressure drops of less than 2.5 inches water column and less than half of compressed air consumption of conventional designs. The increased efficiency was achieved by collecting the finer dust which "puffed" through the high velocity cleaning jet designs. The limitation was that the fine dust would not fall into the collection hopper due to the upward "can" velocity as it entered the filter compartment, especially at the higher gas flows per filter element. The solution was to install an inlet next to the filter bags so that all flow of dirty gas was either horizontal or directed to the hopper, as shown in Figure 5.

There are over 2,000 installations of these collectors installed at double and triple conventionally accepted filter ratios.

When these collectors are designed, it is easy to determine the maximum capacity of a filter collector with orifice connection. The reverse air flow capacity is determined by use of the well documented "jet pump equation" based on the conservation of momentum principle. For writing a specification we will assume that the reverse flow exits each valve at the speed of sound, forming the cleaning jet and that the total filtering capacity of any pulse jet collector is approximately equal to the maximum flow that can be developed from each valve. Table 6 outlines the capacity for different sizes of valves. We add the flow in the jets along a single pulse pipe and multiply this by the number of valves in the collector. These computations are approximate and based on typical venturi designs, and that the total orifice area is equal to 85% of the valve throat area. If the orifice areas total less than the maximum, the capacity is reduced. For example, a one inch diaphragm valve used to clean five bags with 1/4 inch diameter orifices. This would only develop 60% of the valve's potential cleaning capacity. Table 6 can be applied to find the maximum capacity of the collector. The rating is 6 valves x 1350 SCFM x 60% = 4860 SCFM. For full capacity with 6 one inch valves is 6 x 1350 SCFM x 100 % = 8100 SCFM.

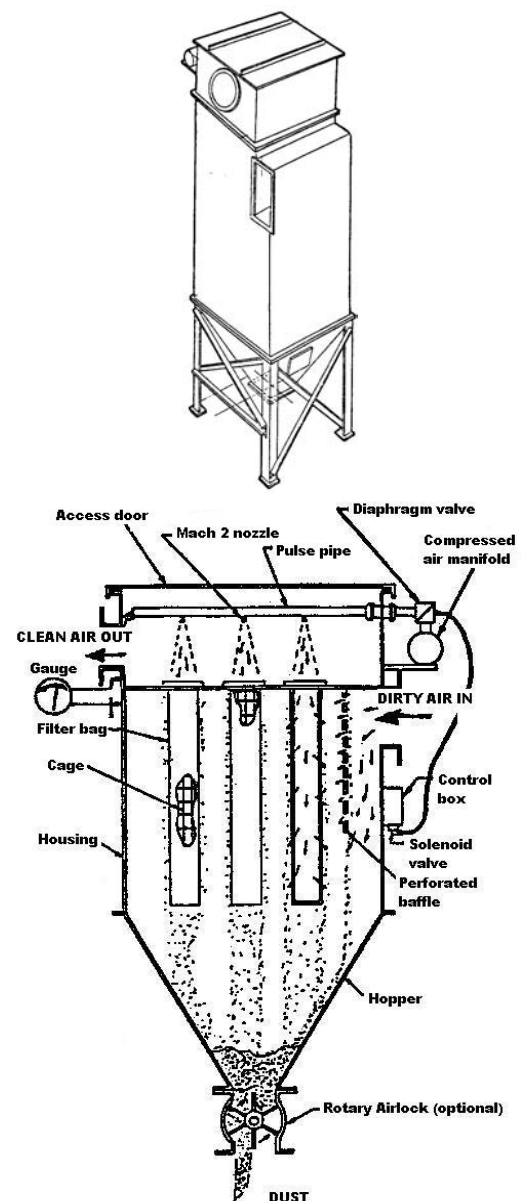


Figure 5

TABLE 6

0.75 inch valve	750 CFM		0.75 inch valve & nozzle	1250 CFM
1 inch valve	1350 CFM		1 inch valve & nozzle	2350 CFM
1.5 inch valve	3000 CFM		1.5 inch valve & nozzle	5000 CFM
2 inch valve	5350 CFM		2 inch valve & nozzle	9000 CFM

Table 6 also shows the capacity when orifices are replaced with converging diverging (Mach 2) nozzles which create a compressed air velocity about 70% higher than a regular orifice. This means we can use less valves to produce the same cleaning performance.

Other Related Design Breakthroughs

Recent developments have opened the opportunities for universal application of this Advanced Technology to new installations as well as modifications of existing installations throughout the world. The dilemma is caused by the equipment acquisition practices of the market place. In the so called modern designs, hopper inlets were universally applied to all large projects. Suppliers with the New Advanced Technology collectors couldn't compete. Engineering firms and power plant operators specified hopper inlets. This required an agreement to change the specifications including regulatory agency approval. The additional cost of re-engineering the ductwork posed an almost insurmountable barrier for the suppliers of advanced technology collectors. The result is that there is not a single installation of this new advanced technology on power plant dust collection systems, in the world. This is in spite of the fact that the technology has been available for over 25 years and is well proven. If we would consider using a collector housing with low velocity cleaning jets and a hopper inlet, this arrangement would face an even bigger obstacle. The cost of supplying such a dust collector is actually higher than the conventional designs. The upward can velocity would have to be 50% lower to allow the finer dust collected, by these advanced technology designs, to fall into the collection hopper(s). This would require a dust collector housing with a footprint much larger than the size of the "high velocity jet" collectors.

Finally a new approach came along to resolve the issue. It allowed the more efficient collectors to be less expensive than the contemporary designs without engineering and size penalties. It also allowed very easy modifications of existing pulse jet collectors around the world.

The breakthrough came when an analysis was made of the widely applied rotating arm collectors. The key to this breakthrough is illustrated in Figure 6. These collectors have been successfully applied to hundreds of fossil fired power generating installations worldwide. If we consider that all of the dust laden air enters from the hopper inlet and if we consider it all came up through the bottom of the bags, the vertical upward can velocity would be extremely high and the fine dust could not fall into the hopper through this upward "can" velocity. Upon analysis, it was determined that for the collector to operate successfully the vertical velocity of the air entering the bag compartment had to be reduced. In rotating arm collectors, the air entered the filter compartments through two separate paths. The first through the bottom of the bags and the rest entered through the cylindrical opening in the center of the collector. This is shown in the illustration to the right in Figure 6. When the open area between the bags in this cylinder was added to the open area through the bottom of the bags, it was sufficient to allow the fly ash dust to make its way into the hopper with a very low effective upward can velocity, In Australia, the supplier of these rotating arm collectors to power plant boilers was able to collect very fine flash dusts by the simple expedient of supplying longer filter bags without modifying the cleaning system.

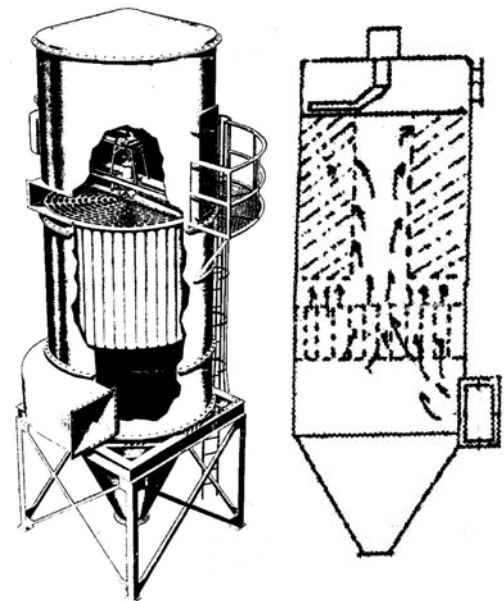


Figure 6

Solution 4; Retrofits Of Existing Collectors, Combining Increased Collection Efficiency With Conventional Inlet Configurations

Applying the rotating arm collector design principle to the retrofit of existing standard pulse jet collectors achieved a simple, inexpensively way of reducing emissions on new and existing dust collectors. The approach is to accomplish the following:

1. Remove all venturis, and cages if the venturis are integral to the cages.
2. Plug 40-50% of the cages along each pulse pipe.
3. Replace pulse pipes with those having converging diverging nozzles over all remaining active filters.
4. Re-install cages and new filter elements. This is illustrated by Figure 7.



Figure 7

The contaminated air will enter through the bottom of bags and the middle of the collector as described in Figure 7 above. Resulting in the particulate emissions entering the atmosphere being over 90% less than conventional dust collectors and power consumption by the collector will be reduced at least 50%.

This approach, applied to all existing dust collectors, can drastically lower global warming. The first reaction is often that it is too good to be true. However it is based on experience, sound engineering analysis and practice. No new research or product development is required.

Remember that retrofits do not require capital expenditures since all needed components are normal maintenance parts.

Conclusion

When we consider the hundreds of thousands of dust collectors installed around the world, of the flawed conventional design, it is easy to understand their tremendous impact to global warming. It is not only the dust emissions produced by these dust collectors that are the problem, but also, the excessive power consumption required to run these dust collectors contribute to global warming from the added emissions at power generating plants needed to supply these dust collectors to.

The good news is that there is proven new technology available that will reduce dust emissions by over 90% and power consumption by over 50%. Now, dust collectors can be part of the solution rather than being part of the problem.