CURRENT RECOMMENDATIONS FOR GIN EMISSION CONTROL

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Abstract

A significant amount of recent research has concentrated on reducing emissions from cotton gins. The USDA-ARS laboratories in Las Cruces and Lubbock have recently completed tests on several modifications to the 1D3D cyclone.

Results from these modifications indicate that significant emission reductions may be achieved. Of equal importance, the same research indicated that these emission reductions may be obtained while reducing the pressure drop across the cyclone.

Introduction

Earlier research by the ginning laboratories found that the 1D3D cyclone had a tendency to re-circulate trash in the lower section of the cyclone cone (Baker, et al., 1995), especially when the cyclone was handling only fine trash. The ginning industry has experienced "roping" in cyclones for many years, especially on mote or lint systems.

Ginners have experienced difficulties with the 1D3D inlet. The relatively tall and narrow configuration of the inlet makes it more prone to choke-ups, especially with large trash.

It is generally recognized that the 1D3D cyclone is more efficient at collecting fine dust than the 2D2D cyclone. On the other hand, there are definite advantages to the 2D2D cyclone in some cases.

After some discussion, it was determined that an in-depth study of the 1D3D cyclone might be in order. The remainder of this paper discusses the practical ramifications of this research, and is based on work done during the past year at the Lubbock and Las Cruces Ginning Laboratories (Holt et al., 1999).

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The four changes discussed in this paper include using a 2D2D style air inlet, increasing the trash outlet size to D/3, adding an expansion chamber to the lower third of the cyclone cone, and using a tapered air outlet tube.

Discussion

This research is very useful, in that it allows a ginner to improve the efficiency of his cyclone system during regular repairs. In addition, these changes will result in a payback, due to improved wear characteristics, reduced choke-ups, and lower back pressure.

Replacing the traditional 1D3D inlet with a 2D2D inlet will lower emissions from the cyclone approximately 8% to 9%. It will also reduce the operational problems associated with the traditional inlet. With this inlet, it becomes possible to use a shorter air outlet duct, as can be seen in Figure 1. Although you don't have to use the shorter tube with the 2D2D inlet, it is advantageous to use it on a new cyclone, because the shorter outlet tube places less stress on the top of the cyclone body during operation.

Replacing the D/4 trash outlet with a D/3 model will give about the same level of emission reduction as the 2D2D air inlet. Fortunately, many existing cyclones were manufactured with this larger outlet size, due to operational considerations.

During the research, it was discovered that air is typically pulled up through the trash outlet on the standard 1D3D cyclone cone. By enlarging the trash outlet size, the airflow was neutralized, which helped to eliminate the roping problem associated with many cyclones.

Many cyclone manufacturers build their cyclone cones in two pieces. The upper 2/3 of the cone is in one unit, and the lower 1/3 of the cone is the second piece. The most common reason given for this manufacturing configuration is that the lower 1/3 of the cone tends to be the part of the cyclone that wears out most quickly. This premature wear is due to the spinning of the fine trash in this area.

Replacing the lower 1/3 of the cyclone cone with an expansion chamber, as seen in Figure 2, will reduce incidence of roping in this area. It also reduced emissions by about 11% during the research studies.

The combination of the above changes reduced PM10 emissions by 24% to 29% on average. In addition, the combination of these three changes reduced the backpressure of the cyclone by almost 17%.

A second innovation shown in Figure 2 is the tapered air outlet. This outlet did not improve emissions from the cyclone; and may have increased emission in some cases. It

did, however, further reduce the pressure drop across the cyclone. The tapered outlet alone reduced backpressure from the cyclone by an additional 10%. In other words, with all four changes, a pressure reduction of up to 27% may be realized, as compared to the standard 1D3D cyclone. In applications where backpressure reduction is a high priority, this option may be useful. When the tapered outlet was used in conjunction with the other three modifications mentioned above, the net result was an equal or lower emissions rate, when compared to the standard 1D3D cyclone.

Summary

Three modifications to the traditional 1D3D cyclone design have been found to significantly improve the collection efficiency of the 1D3D cyclone. At the same time, these modifications will reduce the operational costs of the cyclones, by reducing the backpressure on the system, and by reducing wear problems within the cyclone.

Research indicates that PM10 emission reductions of 24 to 29%, combined with backpressure reductions of 17% may be achieved by these three modifications.

A fourth modification did not improve emissions, but did further decrease the pressure drop across the cyclone. The tapered air outlet modification decreased pressure drop by an additional 10% over the other modifications.
The replacement of standard cyclone cones with modified expansion chambers is easily accomplished during repair season, and is recommended any time a standard cone is to be replaced. The modified inlet should be used on new cyclones, and when existing cyclone bodies are being replaced.

References

Baker, R.V., M.N. Gillum and S.E. Hughs. 1995. Evaluation of new trash collection methods for stripper cotton. In Proc. 1995 Beltwide Cotton Production Conference 1:646-649

Holt, G.A., R.V. Baker and S.E. Hughs. 1999. Evaluation of static pressure drops and PM10 and TSP emissions for modified 1D-3D cyclones. Transactions of the ASAE. **42**(6):1541-1547.

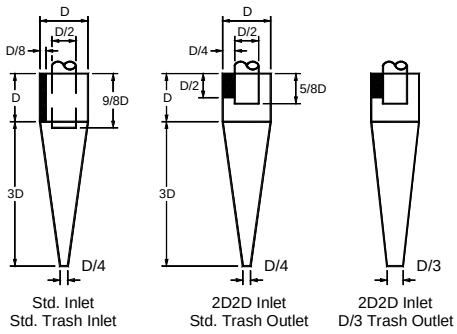

Figure 1. Standard 1D3D cyclone with modifications recommended by USDA labs.

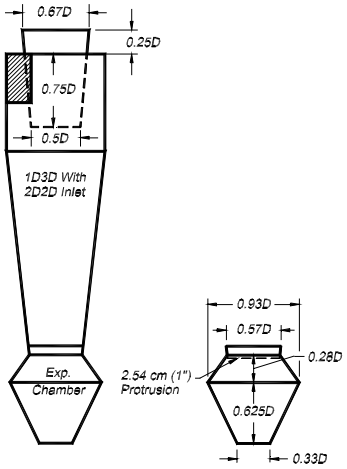

Figure 2. Additional modifications to 1D3D Cyclones that show improvement in collection efficiency include tapered air outlet and expansion chamber on trash exit.