knowing your tco

Chris Polizzi, W.L. Gore & Associates Inc., advises on how to achieve the lowest total cost of ownership in process baghouses.

Introduction

Over the past 25 years or so, kiln baghouses have become the norm for air pollution control at cement plants. If it were not for environmental regulations however, it is questionable whether many cement plants would still use them. Since baghouses rarely add performance advantages to a cement plant kiln operation, they are by most accounts, a burden – and can be a costly one at that. Due to the fact baghouses are a significant cost and, at times, can be a maintenance headache, there are times when a tremendous amount of attention needs to be paid to the large kiln baghouses at a cement plant. Since kiln baghouses generally do not add value to the cement kiln operation and have a main driver to provide environmental compliance, it is understandable that plants want to fulfill the environmental compliance need with the lowest overall cost.

During a recent IEEE/IAS-PCA Cement Industry Conference, 30 cement Plant Managers were interviewed on the operation of kiln and clinker cooler baghouses at their plants. They were asked the following question: for the kiln and cooler baghouses at your plant, do you want the overall lowest total cost of ownership (TCO), including items such as filter bag purchase, labour to install filters, fan energy costs, compressed air cost to pulse clean the filters, compliance stack testing costs, etc?

Unsurprisingly, all thirty cement Plant Managers responded that "yes", they do in fact desire the lowest TCO to operate their kiln and clinker cooler baghouses.

The same 30 cement Plant Managers were then asked a follow up question: do you or does someone

at your facility currently know the TCO to operate your kiln and clinker cooler baghouses? This could be in dollars per year, dollars per tonne of feed, or in dollars per tonne of clinker produced.

Pause for a moment and think about whether you know the total all-in cost to operate the kiln and clinker cooler baghouses at your plant. Of the 30 cement Plant Managers interviewed, only one knew the TCO of their kiln and clinker cooler baghouses. How could it be that everyone desires the lowest TCO in their kiln and clinker cooler baghouses, and yet almost everyone has no idea what the total costs are. Without knowing what the costs are to operate these baghouses, how could a Plant Manager know if they are achieving the lowest TCO or not?

It is also worth noting that essentially all of these Plant Managers did know the purchase price of the filter bags used at their plants and their expected bag life. So could it be they were using the purchase price of the filter bag as a surrogate for the TCO of their kiln and clinker cooler baghouses?

Capital cost is not TCO

When this author asks cement producers for the largest cost that goes into the total operational cost of a baghouse, almost unanimously, they state the capital purchase price of the filter bags. Most cement producers are then surprised to learn the capital purchase price of filter bags accounts for less than 25% of the TCO in process baghouses.

Example TCO analysis: initial cost

Consider an example of the TCO of operating a kiln/mill baghouse at a cement plant. In the example, it is assumed that the plant has a pulse jet cement kiln baghouse that uses 6000 filter bags and a design airflow volume of 750 000 acfm. The plant is preparing for a complete kiln baghouse filter bag replacement as part of its annual maintenance outage and has solicited bids for filter bags. The bids have returned, and the plant has to make the decision between two very different price alternatives.

The plant could use the same generic membrane filter bags it has in the past. These filters cost US$62 per filter bag and have a warranted filter bag life of four years. As an alternative, the plant could choose a premium membrane filter bag engineered to operate with a significantly lower filter drag. The alternative low drag filter bags would cost US$97 per filter and also have a warranted filter bag life of four years. Since the cement plant in this example wants to have the lowest TCO, how could it possibly select the more expensive filters, which have over a 50% purchase price premium and the same warranted filter bag life?

Digging deeper

Hopefully, the Plant Managers would want additional information and would look more holistically at how each of the alternative filters will affect the overall TCO of operating the kiln baghouse. Here is some additional information to factor into the analysis.

The forecasted operating time of the kiln will be roughly 330 days per year and the plant has an electricity utility cost of US$0.065/kWh. The cement plant is located in the US and is held to US Environmental Protection Agency National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations which will require at least one Method 5 Stack Test per year. The Method 5 Stack Test will have a cost of approximately US$20 000/year, if the plant remains compliant. This stack test will be used to set the plant's baseline for its Continuous Parametric Monitoring System level to ensure compliance.

In the example, the baghouse fan motor has a variable frequency drive, and the fan has typically operated with a static pressure of -12 in. of water gauge at the fan inlet, while using generic membrane filter bags. The alternative premium membrane filters are engineered to operate at a 20% lower filter drag. The plant put together a comparison of the two filter bag offers (Table 1).

To further analyse which choice should be made for the kiln baghouse in the example, the plant needs to better understand what is meant by 20% lower drag membrane filter bags and, more importantly, what benefits would be achieved by using them. In the May 2016 issue of *World Cement*, an article was published on the concept of filter drag and the benefits of utilising filters that have the lowest possible filter drag.[1]

Table 1. **Comparrison of membrane and GORE® low drag filter bags.**

	Membrane filter bag	GORE® low drag filter bag
Filter bag price	US$62 per filter	US$97 per filter
Filter bag installation labour cost	US$15 per filter	US$15 per filter
Filter bag life	4 years (est.)	4 years (est.)
Environmental compliance risk	Low risk	Low risk
Filter drag or filter resistance	Standard membrane drag	20% lower drag membrane
Electricity utility rate	US$0.065/kWh	US$0.065/kWh
US EPA Method 5 Stack Test	US$20 000	US$20 000

Table 2. Cash flow data for membrane filter bag.

	Year 1	Year 2	Year 3	Year 4	Total cash outlay
Bag cost	US$464 256				US$464 256
Installation cost	US$112 320				US$112 320
Fan energy cost	US$722 939	US$722 939	US$722 939	US$722 939	US$2 891 758
Compressed air cost	US$45 123	US$45 123	US$45 123	US$45 123	US$180 494
Compliance stack testing	US$20 000	US$20 000	US$20 000	US$20 000	US$80 000
Total cash outlay	US$1 364 639	US$788 063	US$788 063	US$788 063	US$3 728 828

Table 3. Cash flow data for GORE® low drag filter bag.

	Year 1	Year 2	Year 3	Year 4	Total cash outlay
Bag cost	US$724 464				US$724 464
Installation cost	US$112 320				US$112 320
Fan energy cost	US$602 450	US$602 450	US$602 450	US$602 450	US$2 409 798
Compressed air cost	US$39 107	US$39 107	US$39 107	US$39 107	US$156 428
Compliance stack testing	US$20 000	US$20 000	US$20 000	US$20 000	US$80 000
Total cash outlay	US$1 498 341	US$661 557	US$661 557	US$661 557	US$3 483 010

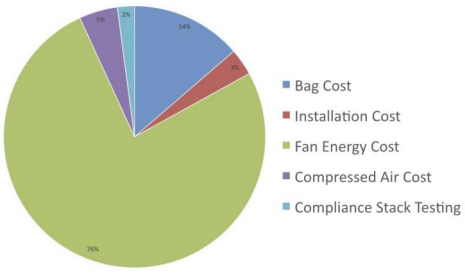

Figure 1. TCO for a pulse jet cement kiln baghouse using generic membrane filter bags.

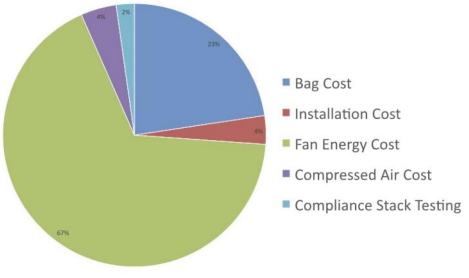

Figure 2. TCO for a pulse jet cement kiln baghouse using GORE® low drag filter bags.

Figure 3. Cash flow breakeven and benefit of using GORE® low drag filter bags.

Filter drag and its impact on TCO

Filter drag is the total resistance of the filter media and the dust cake on the surface of the filter media. The combination of the media and the dust in and on the media are a significant resistance in the baghouse, which clean gases before they leave the stack. The higher the resistance, the higher the energy consumption of the baghouse fan and, therefore, the higher the cost to move the necessary kiln process airflow across the filter media.

In a baghouse, filter drag is defined as the relationship between operating differential pressure and the actual air-to-cloth ratio at which the baghouse operates:

$$\text{Filter Drag} = \frac{\text{Differential Pressure}}{\text{Air-to-Cloth Ratio}} = \frac{dP}{A/C} = \frac{\text{“mm}}{\text{m}^3/\text{min}/\text{m}^3}$$

Once the concept of a lower filter drag is understood, by installing filter bags with a lower filter drag, cement producers understand they will be able to choose their desired benefit from the following:

1. Fan energy savings.
2. Increased airflow.
3. Longer filter bag life.
4. Decreased number of installed filter bags.

Additionally, based on changes in the market, a plant could change the benefit it wishes to receive at almost any time.

For the example in this article, it is assumed that the cement plant could not benefit from more airflow so the analysis is based on an evaluation of fan energy savings, as a result of using filter bags capable of operating with a lower filter drag relative to the typical membrane filter bags the plant has used in the past. A cash flow comparison analysis has been put together for the decision process for each alternative filter bag choice (Tables 2 and 3).

From the cash flow analyses of both options, the plant can now see exactly where the various costs of each component of their TCO are relative to one another and what costs dominate the overall picture (Figures 1 and 2).

Conclusion

As can be seen in the cash flow analysis, the generic membrane filters are significantly cheaper in terms of initial filter bag cost (US$62 per filter versus US$97 per filter). The higher-priced low-filter-drag filters, however, will require significantly lower energy consumption at the baghouse fan. Based on the lower in-use resistance of the low drag filters, the baghouse fan energy requirements are less and result in a much lower electricity cost to operate the fan motor. The fan energy savings are so significant: despite the filters being over a 50% premium, the cash flow return on investment breakeven point is approximately two years. In years three and four, the low drag filters begin generating a positive cash flow relative to the generic membrane filter costs. Over the four year filter bag life, the low drag filters would result in a US$245 000 positive cash flow benefit (Figure 3).

This example illustrates how making an investment in a higher-priced alternative engineered for a better-performing filter bag, provides a significant lower TCO in the operating of a large kiln baghouse. As with many financial decisions, you get what you pay for.

References

1. POLIZZI, C., "What a Drag", *World Cement* (May 2016), pp. 30 – 34.

About the author

Chris Polizzi is an Applications Engineer with W.L. Gore & Associates Inc. He has been involved in the air pollution control and cement industries for over 20 years.