

ENERGY SAVING GUIDE

FOR

SPRAYBOOTH OVEN EQUIPMENT

June 2006 v1

Background

The debate on energy saving has intensified in recent times, stimulated by the rising cost of fuel and electricity. Equipment manufacturers are developing new products that will reduce energy consumption to counteract the escalating energy costs. These energy saving products are a useful sales tool for equipment manufacturers to promote the benefit of their systems. There is nothing wrong with this, in fact it is a good thing as the customer will directly benefit from this program of market driven development.

The array of energy saving products on the market can be confusing. Information is provided in a number of different ways, often without sufficient explanation of how the savings are achieved. Added to this you have government incentives such as the Enhanced Capital Allowances scheme (ECA) and Carbon Trust Loan scheme (CTL) to wade through.

This document is intended as a basic guide to reducing the energy consumption of a spraybooth oven.

CONTENTS

1. Why save Energy?
2. Identifying Energy Saving Areas
3. Auxiliary Air Movement
4. Variable Airflow
5. Automatic Air Recirculation
6. Direct v Indirect Firing
7. Lighting

Please note that the information contained in this document is intended as a guide only. Spraybooth oven manufacturers can provide more detailed information about energy consumption.

1. Why Save Energy?

Well we said it would be a basic guide so why not start at the very beginning!

The amount of money spent on energy each year directly impacts on the profit a business makes. Bodyshops in general can be classed as high energy users relative to the size of the business, and when this elevated energy cost is combined with a low net profit expectation the impact of rising fuel and electricity costs is a burden many companies will struggle with.

The increases in energy costs are not insignificant either. It is estimated that natural gas has increased by over 40% in the last three years. Electricity has increased by a similar amount. More worrying is that the trend is expected to continue.

To put the energy issue into context lets put some average numbers down;

The natural gas and electricity required to run a spraybooth oven can cost on average between £2.50 and £15.50 per top-coat job. The cost increases to between £5.00 and £25.00 when a job includes high build primer and top-coat. This huge difference is determined by the performance of the equipment and energy efficiency (which is detailed in a later section).

Example 1 (top coat only);

Average job value	£850.00
Net profit expectation 5% =	£ 42.50
Typical energy saving per job	£ 8.00
Realised net profit per job	£ 50.50

Example 2 (top coat only);

Using the figures above, if a Bodyshop produces 50 vehicles per week for 50 weeks of the year and saves £8 per vehicle. This is the equivalent to processing an additional 470 cars per year, over 9 cars per week, without having to do the work.

It should be noted that some Bodyshops could make large energy savings others much less it all depends on how efficient the spraybooth oven is and how many jobs are processed.

In summary the energy used in proportion to the net profit of a Bodyshop is enormous and every effort should be made to pay less to the energy company and improve bottom line profit.

2. Identifying Energy Saving Areas

There are many ways that a spraybooth oven can be made more energy efficient. In this section we identify these options and give each a £ sign indication of how effective the energy saving measure is.

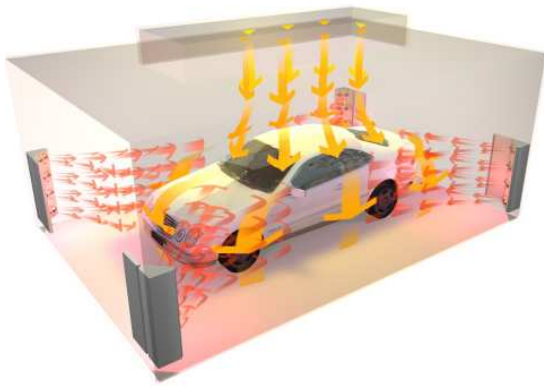
Item	Saving Type	Effectiveness
Lighting	Electrical	£
Variable airflow	Fuel & Electricity	££££
Automatic Air Recirculation	Fuel	££££
Automatic booth idle	Fuel & Electricity	££££
Process time reduction	Fuel & Electricity	££££
Lower bake temperature	Fuel	££
Off car panels painted with Vehicle	Fuel and electricity	££££
Job right first time	Fuel and electricity	££££
Cabin auto-balance	Electricity	£
Efficiency 1 motors	Electricity	£
Cabin Insulation	Fuel	£
Direct v Indirect firing	Fuel	£££

£ = Lowest saving
££££ = Highest saving

Auxiliary Air Movement (AAM)

The most significant change to the design of a spraybooth oven in the last 20 years is the addition of auxiliary air movement (AAM) within the cabin. AAM was first introduced in the late 1990s to aid the drying of waterborne base-coats. Since then it has been developed further to work on the bake cycle as well. Most spraybooth manufacturers now offer some type of AAM

AAM systems deliver an additional airflow to the spraybooths ceiling input plenum, normally through high velocity nozzles. The additional auxiliary airflow disrupts the laminar air flow over the vehicle or panel and speeds up the flash off and curing process.



How Do AAM's Save Energy

The use of AAM saves energy in a number of ways;

- Reduces process times. Spraybooths with AAM will have faster flash off cycles and shorter bake cycles than conventional equipment. If the spraybooth is working for a shorter period of time then switched off it will save both fuel and electricity. Overall process times can be reduced by approximately one third.
- The baking temperature can be set lower as the system is much more efficient at getting heat from air into the vehicle / panel. Panel temperatures are much closer to the air temperature with AAM in use.
- The improved efficiency allows the spraybooth main airflow to be lowered for flash off and curing cycles (detailed in the variable airflow section).

We can put some approximate numbers to the savings;

Example; typical booth, direct gas fired handling 50 jobs per week for 50 weeks a year.

Conventional booth energy cost over 5 years = £124,000

Spraybooth with auxiliary air movement = £ 73,000

Saving in booth energy over 5 years = £ 51,000

Variable Airflow

Historically spraybooth ovens have been designed to operate with one air flow-rate regardless of the type of work being done inside it. The booth was either on, running at full airflow, or it was switched off. There were only two modes available, spray and bake.

Imagine sitting in your car at traffic lights with your engine at full revs. You wouldn't do it. You would only apply the power as you need it. The same thought process can be applied to the spraybooth. The spraybooth is not just used for spraying and baking, the process can be further divided;

- Idle
- Load / unload
- Cleaning / final masking
- Spraying
- Flash off
- Baking

With modern spraybooth oven design incorporating auxiliary air movement you only need the full air rate (full revs) for the spraying mode, all the other activities can be carried out with a lower airflow.

This item is listed as ££££ in the effectiveness table because it is a very practical way to dramatically reduce energy costs. If we put some figures to the possible savings it will help demonstrate this point.

- Reduce airflow by 50% = 50% fuel energy saved
- Reduce motor speed by 50% = 80% electrical energy saved
- Automatic spraybooth idle = 70% less energy used

Example; typical booth, direct gas fired handling 50 jobs per week for 50 weeks a year.

Conventional booth with fixed airflow, energy cost over 5 years = £124,000

Variable airflow booth with auxiliary air movement = £ 43,000

Saving in booth energy over 5 years = **£ 81,000**

Variable Speed Drives (vsds)

Variable airflow is achieved by using variable speed drives to control the main fan motors. A static variable speed drive is an electronic unit which provides infinitely variable control of the speed of a three-phase ac induction motor by converting fixed mains voltage and frequency into variable quantities. Whilst the principle has always been the same, there have been many changes from the first VSDs which featured thyristors to today's microprocessor controlled digital units. Variable speed drives are used extensively in industry for production applications and are extremely durable and reliable in use.

Automatic Air Recirculation

The previous description of how the activities in a spraybooth oven can be separated for variable airflow can also be used to determine when a booth needs full fresh air intake and exhaust and when the air can be recirculated.

Traditionally spraybooth ovens operate on full fresh air for the spray cycle and recirculation for the bake cycle. Technology is now available from spraybooth manufacturers where the spraybooth will automatically switch to recirculation mode for idle, loading / unloading, cleaning / final masking, flash off and bake modes. A spraybooth oven only requires full fresh air for the paint application process.

How does this save energy?

With the spraybooth in spray mode all the airflow is taken from an external point, it is heated to spraying temperature and supplied to the cabin through ceiling filtration. This air is extracted from the cabin and discharged back to an external point. All of the fuel energy used to heat this air to spraying temperature literally goes up the chimney and is wasted.

Example; An average spraybooth on natural gas will use 101 Kw of fuel to get from 10 deg centigrade external air temperature to 22 deg C cabin air temperature. During the winter months say 0 deg C this figure rises to 186 Kw. This is equivalent to running 15 standard size domestic boilers in your home with all the windows wide open.

Switching into recirculation mode reduces the energy useage dramatically as only 10% fresh air is used with 90% being recirculated through the cabin.

Example; The same spraybooth above switched to recirculation instead of full fresh air,

At 10 deg C external air temperature = 14 Kw

At 0 deg C external air temperature = 16 Kw

This is equivalent to having slightly more than one standard size domestic boiler running.

Because the spraybooth can now recirculate air for all operations other than spraying the overall effect on running costs is a significant cost saving as demonstrated below.

Example; typical booth, direct gas fired handling 50 jobs per week for 50 weeks a year.

Conventional booth Energy cost over 5 years = £124,000

Recirculation airflow booth with auxiliary air movement = £ 55,000

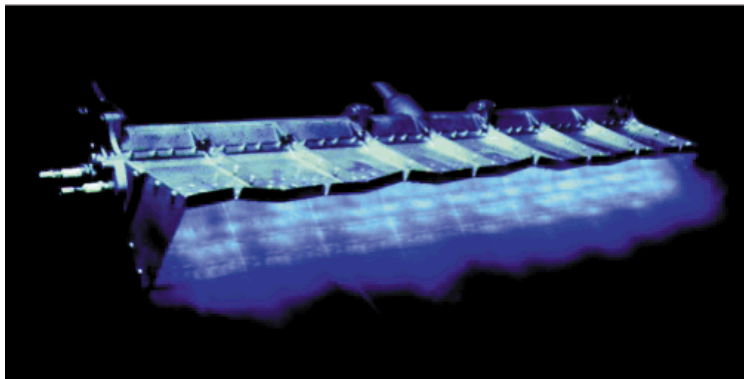
Saving in booth energy over 5 years = £ 69,000

Direct v Indirect Firing

The choice of having a direct or indirect fired spraybooth oven is only an option for natural gas or LPG users. Oil fired systems are always indirect as the fuel does not burn cleanly enough for direct systems.

An indirect fired system is where the gas burner fires into a combustion chamber which is connected to a heat exchanger. The hot combustion gasses pass through the heat exchanger and are discharged through a flue to atmosphere. These hot flue gasses do not mix with the air being supplied to the spraybooth. The heat exchanger transfers the heat energy from the combustion process into the spraybooth air stream. Approximately 20% of the fuel energy used in this process is discharged up the flue as waste.

A direct fired system removes the heat exchanger from the process. The flame burns directly in the spraybooth air flow normally in a purpose built housing. "V" type burners are a very common form of direct gas fired burner as shown below. The products of combustion are not wasted but are used in the heating process. The massive dilution rate of spraybooth fresh air in relation to the combustion gasses means that the system is ideal for the application.



In summary the energy saving benefits of direct firing over indirect firing are;

- Overall saving of approximately 30% fuel energy cost.
- 20% fuel saving from utilising the combustion gas more effectively
- 10% fuel saving from the speed of temperature rise and cool down.
- Faster production process as temperatures are achieved more rapidly.

Example; typical booth, gas fired handling 50 jobs per week for 50 weeks a year.

Indirect fired booth	Energy cost over 5 years = £171,000
Direct fired booth	= £ 123,000
Saving in booth energy over 5 years	= £ 48,000

Lighting

Spraybooth lighting needs to be to a good lux level, as uniform as possible and without glare. Most spraybooth manufacturers have a target figure of 1000 lux measured at floor level around a vehicle.

Can you have too much light?

You can, the intention is to illuminate the vehicle in order to see clearly when applying paint materials. Too much light will add glare and actually reduce the amount you can see as the eye naturally reacts to the brightness. Too much light is also a waste of energy.

- **Look at how much light you need, not how bright the cabin is.**

Light Tube Type

Light tube manufacturers have over the years developed more efficient lighting systems. T8 fluorescent tubes are the most common lamp in use today but there are more efficient alternatives such as T5 and DL type tubes. These light tubes have a greater lumens output for a given energy input.

- **Use the most efficient light tubes**
- **T5 or DL tubes can use 20 % less energy than conventional tubes.**

Reflectors

Reflector design can also help to reduce the lighting energy load. A basic reflector is simply a white tray with light tubes mounted onto it. This is the least efficient type of reflector. You can reduce the number of light fittings in a spraybooth by fitting an efficient reflector. The efficiency of a reflector can be improved by shaping to suit the purpose and using more reflective materials. Specially coated aluminium reflectors are widely used, similar to the type you see in offices and stores.

- **Look for aluminium coated or similar high efficiency reflectors**
- **A shaped reflector will be more efficient**

Lamp Starting And Running Gear

The electrical equipment we use to start and run the lamp also has an effect on efficiency. Standard fluorescent light fittings will be fitted with a low frequency ballast and replaceable starter. This is a very common fitting used widely in industry but it is not the most efficient.

High frequency electronic starters have considerable benefits over standard fittings. They are maintenance free, do not require replacement starters, have flicker free start, and provide more light output and extend tube life.

- **Use a high frequency electronic light ballast**