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Energy Conservation Through Vacuum Coating & Metalizing Process – Case Study

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ABSTRACT

This paper represents the result of the end user and equipment manufacturer joined effort to set up an highly efficient vacuum coaters as requested by the high competitive metallized film market for flexible packaging. In order to be competitive in this global business, the demand was for production efficiency, energy saving at controlled and consisten quality level, in order to minimize the production cost. The paper will discuss three aspects characterizing current demand for High Efficiency vacuum coaters : Productivity and production efficiency Energy saving strategies Quality requirement with particular focus on achieving high barrier properties in metallized film India and other industrial nations are faced with the unprecedented challanges of providing energy services to an expanding economy in a manner which is environmetly and economically sound, energy efficiency emerged as the most effective manner to reduce dependecies on foreign oil import, minimize emission which contributes to global warming and stimulate local economies, this paper discuss how current and future application of vacuum coating technologiescan play a significant role developing many of these energy efficiency consumer good.

I. INTRODUCTION

Energy is wasted each day due to lack of awareness among society. The prices of oil and natural gas have gone through the roof roof and are expected to stay there. A continuously increasing trend of such high energy of price will have negative effects on the global economy and society . The effects include recession, inflation and higher unemployment on global economy and society. India also feels the effects of energy problems as the priceof petrol and diesel sought a new hike. The decision to increase the price of fuel was to overcome the impact of rising international crude oil prices and to curb the increase in subsidies paid by the government. The increase in energy price means that energy conservation efforts should be taken to reduce the effect 59 of energy cost.

As stated by Yukata Mizuta (2003), energy conservation may not only bring reductions in carbon dioxide emission, It may also lead to savings in the expenditure on energy. It should therefore be one of the first problems to receive the attention of the government to be tackled. Besides of saving money and energy saving effort can also improve the quality of environment and extend the life span of non renewable energy resources. In general, there are two kinds of energy saving methods that are technology fixed and behavioural approach (Wong, 1997; Mohan et.al, 1983). These two energy conservation methods were highlighted in the next two sections and discussions for each method will focus on the definations, exaample and its usefulness.

In industry the vacuum coating and metalizing process is a booming, mainly in cosmetic industries requirement is on high level, because vacuum metalizing and caoting, option like spray paiting which creates harm to nature and spreading more amount of pollutants, vacuum coating and metalizing is best option with energy conservation.

The motivation behind this reveiw paper is, there was a growing demand of metallized film in several geographical region which led the film manufacturing companies to invest in new equipment : in order to be competitive in this global business, the demand was for production efficiency, energy conservation at controlled and consistent quality level, in order to minimize the production cost.

The paper will discuss three aspects characterizing current demand for High Efficiency vacuum coaters :

a. Productivity and production efficiency
b. Energy saving strategies
c. Quality requirement with particular focus on achieving high barrier properties in metallized film.

PRODUCTION EFFICIENCY : In the Production efficiency of a roll-to-roll vacuum coater for aluminium deposition depends on the four main factors listed here :

- ✓ Actual metallization speed
- ✓ Uptime vs. Downtime,
- ✓ Machine utilization factor
- ✓ Wastes

To measure the effect of each single factor (speed, down time, machine utilization and waste) on determining the total productivity, and its useful a sensitivity analysis which measure the change of the production output for any factor proportional change. Not suprisingly, the greater impact is from web width, counter balanced by the detrimental effect of poor machine utilization due to unbalanced product mix, In this downtime reduction looks crucial as well. A similar approach is done to evaluate the relative weight of the factors on the production cost. In this case, machine size has, somehow, a more limited effect due to the complexity and infrastructure cost of a very wide machine. The relative limited effect of waste film on the production cost is possibly true for film manufacturers, who have the opportunity to reprocess film scraps almost entirely, whereas for the film converters it becomes a real and net wasted material with relevant higher cost impact.

II. METHOD & MATERIALS

Downtime reduction :

The main phases contributing to the machine downtime are :

- ✓ Vacuum generation
- ✓ Machine cleaning
- ✓ Diffusion pump proper maintenance
- ✓ Silcon Oil replacment before de gradation, to avoid yellow ness on the article while metalizing.

Waste minimization :

Waste minimization is the another important item characterizing the latest generation, high efficiency metallizers : a maximum of 3% film waste through the whole production is a demanding but reacheable target. Two examples of solution for waste reduction are a full production monitor and automatic control through supevision and data recording, aluminium thickness continuous measuring and control, cameras for defect monitoring.

Plasma Treatment

Many films are positively affected by plasma treatment. High speed metallizers require the use of higher power density plasma. The case study described in the last part of this presentation will demonstrate the benefit of a «treatment dose» in excess of 450 – 550 Joule/m2 corresponding to delivering power in excess of 6Kw per meter of width which has been so-far considered the maximum standard.

Energy Saving :-

The Electrical Energy represents a major metallization cost items. It accounts for half of all consumable costs and 30% of the total metallization cost . A strategy to optimize the use of energy in metallization is one of the main current efforts to implement high efficiency metalizing chamber.

The nature of metallization process characterized by intensive heat requires an high capacity, somehow redundant cooling system. Energy reduction strategies can be implemented by the optimization of the power demand of selected phases of the production cycle time without compromise for the system safety .

The Energy Saving solutions address two areas of the intensive energy use , that is the pumping group and the refrigeration unit for the chilled drums cooling system.

- All major pumps are switched off for most of the downtime
- Diffusion pumps heating and temperature are controlled to minimize the power consumption
- The refrigeration unit can be designed with variable capacity compressors to tune the power demand to the minimum safe value.
- Efficient Mechanical boosters and Vacuum pump to be utilised.

They represent an estimated 10-15% of energy saving over an average production cycle. In addition to Energy saving , energy recovery system can be implemented by means of the use of heat pumps (this approach, which requires additional equipment and a more factory integrated strategy is not covered by this paper).

Metallization Speed : A representative value of the industry state-of-the-art high metallization speed for Pet or PP is 1000 m/min at 2 OD with 5% deposition uniformity. Key points of this is to consistently maintain this performance are : evaporation system, film cooling efficiency

The evaporation system is the crucial part of any aluminium metallizer : high deposition rate and evaporation stability are instrumental to match-up with the high metallization speed. The ceramic evaporation boats needs to be powered and fed to deliver about 90% of the current maximum capacity standard. Design solutions for high evaporation boats are :

- Narrow spaced evaporators for a dense deposition cloud
- Stable aluminium feed
- Balance power distribution
- Integral cooling to withstand high intensity heat and long metallization run
- Efficient working of Vacuum pump and Mechanical Booster Pump.

The winding system of an high speed metalizing chamber is designed to steadily support and guide the film during metallization : the main design features are :

- Low inertia rollers normally fabricated with high modulus of rigidity material to guarantee rigidity and its lightness.
- Smooth surfaces roller to minimize the risk of film damage
- Tension control using latest generation of drive control system

Film cooling is a key requirement for high speed metallizers. For popular metallized materials such as Bopp, a very small temperature increase is allowed during the process. Chilled rollers are common solutions to remove the heat from the film with the heat exchange being enhanced by injection of a small quantity of gas to create a localized «high pressure” chamber between the film and the chilled roller

III. RESEARCH METHODOLOGY :

The efectiveness of technological advances in energy efficient products is being increased by a new intrest in energy efficiency among many gas and electrical utilities through out the India. Utilities and their state regulators are reaizing that the primary objective utilities to be provided energy services at the lowest overall cost not just to provide more energy supplies. Many utilities are being actively encouraged to invest and to make a profit in a conservation and in a manner analogous to investment in a new power palnt.

The result in a huge new source of capital for energy efficiency investment, further more utilities are intrested in investment with longer terms payback than the typical consumer; an energy efficient window with a ten year payback and a lifetime of twenty years is a great investment for utility even though it may not seems as compelling to first time to homeowners.

Sophoticated but cost effective means for controlling light and heat will continue to play an important role in meeting the energy efficiency challanges. Vacuum deposited thin film coatings have played an important and growing role in efficiency gains of the last fifteen years and have the potential to continue to do so in the next decades.

IV. CASE STUDY

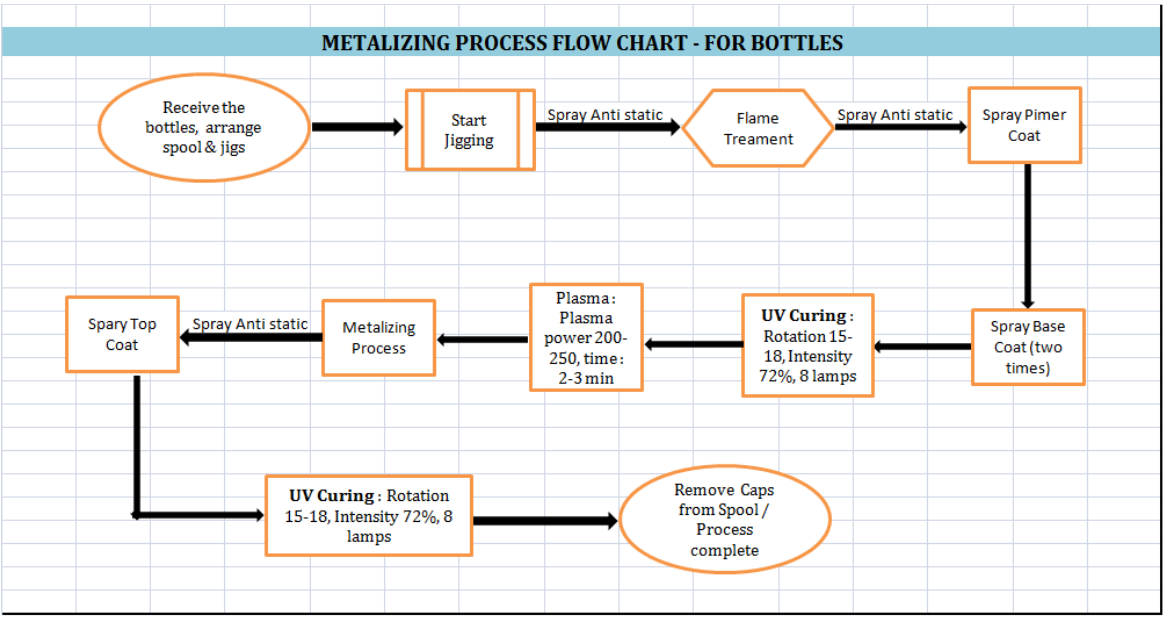

Figure 1

METALIZING PROCESS ON GLASS BOTTLES :-

1) FLAME TREATMENT ON BOTTLES : 10 sec.
2) PRIMER COATING : 10 sec.
3) BASE COAT : 15 sec.
4) UV CURING : 1 min.
5) PLASMA TREATMENT : 5min
6) VACUUM METALIZING PROCESS : 12min
7) SPRAY TOP COAT : 10 sec
8) UV CURING ON BOTTLES : 1.5min.
9) PROCESS COMPLETE

Total time to complete one Metalizing Cycle : 20 minutes 15 sec.

Table 1

NAIL POLISH CAP PP MATERIAL SPRAY & MATT TOP COAT COMPARISON			
SPRAY			
DESCRIPTION	**RATE**	**CONSUMPTION**	**TOTAL**
Stoving black	₹ 269	1	₹ 269
thinner	₹ 108	0.300	₹ 32
hardner	₹ 269	0.100	₹ 27
primer	₹ 237	0.500	₹ 119
		TOTAL	**₹ 447**
OUTPUT = 1200 NOS			
PER PIECE	**447 / 1200**	**0.372**	
MATT TOP COAT			
DESCRIPTION	**RATE**	**CONSUMPTION**	**TOTAL**
MATT TOP COAT	₹ 590	1	₹ 590
PRIMER	₹ 384	0.588	₹ 226
		TOTAL	**₹ 816**
OUTPUT = 2700 NOS			
PER PIECE	**816 / 2700**	**0.30**	

V. CONCLUSION

Vacuum metalizing Process discussed three key aspects of a state-of-the –art high efficiency metallizers :

- ✓ Money saving compare to Spray painting.
- ✓ Quality finish, Gold and gun metalizing can be done.
- ✓ Quanity for mass production
- ✓ Asthetical look is great, compare to Spray and powder coating finish,
- ✓ compatative in global market

Collected from months of metallized film production line have been analysed to identifythe barrier improvement factors, including shop level comparison among different generation machines(full data factor analysis still in progress).

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