Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Week – 05
Lecture – 23

Welcome to the NPTEL online certification course on modern food packaging technologies regulatory aspects and global trends. In the last lecture we have seen the different properties of the plastic films. Now, the coating, printing and labelling of plastic films and the topic we will be covering in this lecture is coating of the plastics which will be including acrylic coating, PVDC coating, PVOH coating, low temperature sealing coatings, metallizing with aluminium, silicon oxide coatings, diamond like coatings, extrusion coatings with polyethylene and in printing we will be covering, gravure printing, flexo graphic printing, digital printing and in labelling of the rigid plastics we will be seeing in mould labelling, dry offset printing, silk screen printing, heat transfer printing. Coatings are applied to the surfaces of plastic films to improve heat sealing and barrier properties. They are also applied to rigid plastics to improve barrier. Traditionally the most common method of application to film has been by using an etched roll as this gives consistent and accurate coating with weights up to around 6 gram per meter square.

This level of coating is commercially available from film manufacturers. If higher coating weights are required this is normally carried out by converters. With environmental concerns being an important factor water based coating systems have been developed. It is unusual to find solvent based systems being used today where they are used they are mostly alcohol based with butanol being the highest boiling point solvent used.

Printing coats are applied where the coating is to be applied on both side of the film. The primer is applied to both sides simultaneously using reverse driven gravure rollers. Addition to the base film is essential and hence an adhesive-type coating with anti-static properties is normally used with a coating weight of less than 1 gram per meter square. Metalized coating using aluminum has been available for some time. More recently a mixture of silicon oxides has been deposited in thin layers on several plastic films.

Extrusion coating is also a method of applying a plastic coating though this usually refers to the application of plastics to other materials such as aluminum foil, paper and paper board. Coating as a technique for improving the properties of plastic film and containers is an active area for innovation. The first of this coating is acrylic coatings.

Acrylic coatings are applied to plastic film particularly oriented polypropylene. The coating is glass clear, hard, heat sealable and very glossy.

It has an initial sealing temperature of around 100 degree Celsius. The melting point is sharply defined. This means that the coating can easily slide over hard surfaces without sticking. A typically acceptable lower sealing strength would be 250 grams per meter square per 25 millimeter seal width. With the film shrinkage temperatures of 150 degree Celsius this would give a sealing range of 50 degree Celsius.

It is necessary to have some slip and anti blocking compounds incorporated in the coating to achieve the best packaging machine runnability. The coating thickness is generally about 1 gram per meter square and with a specific gravity close to 1. This gives a thickness of 1 micrometer. The another coating is PBDC coating. PBDC or polyvinylidene chloride coatings may be modified to produce either a good heat sealing polymer or a high barrier polymer.

There is a compromise to be made between the quality of sealing and the barrier properties required. Modification of the polymer to give a wider sealing range lowers the threshold for sealing to around 100 degree Celsius at the expense of the gas barrier. PBDC coatings are applied to films and paper. The majority of general purpose coatings supplied will have sealing properties starting to seal at 120 degree Celsius and oxygen barrier of around 25 ml per meter square per 24 hours. For PET film PBDC is normally chosen for high oxygen barrier that is 10 ml per meter square per 24 hour and as a result may have poor sealing properties.

The formulations needs to incorporate both silica and waxes as slip and anti blocking agents to prevent the coatings from sticking to the hot sealing surfaces. Typically film producers apply coating weights of 3 grams per meter square or 2 grams per micrometer thickness. The specific gravity of PBDC is 1.3. Surface coatings can be applied to rigid containers such as the surface of PET beer bottles.

The another type of coating which is generally applied is polyvinyl alcohol coatings. With the environmental concern that dioxins may be produced if chlorine based compounds are incinerated and alternative high gas barrier has been shot to replace PBDC without needing to modify coating parameters. PBOS emulsions meet this requirement, but they are sensitive to moisture losing barrier properties if the relativity increases to more than 65 percent. Films with polyvinyl alcohol are therefore, likely to be used as a part of a laminate with the PBOS on the inside of the web. Biaxial oriented polypropylene with PBOS on the outer side can be used provided it is over lacquered with a protective varnish.

PBOS also has no sealing properties. It is however, an excellent surface to receive printing inks with low absorption or retention of solvents. Coating weights are similar to PBDC, but the specific gravity is nearer to 1 and film yield is slightly higher. Now, the low temperature sealing coatings. Low temperature sealing coatings for OPP which seal at lower temperatures and have a wider sealing range are required to meet the demand for faster packaging machine speeds.

These coatings based on inomer resins applied in the form of emulsions are an alternative to both acrylic and PBDC coatings. As silica and waxes are likely to raise the sealing temperature threshold of any coating, they are kept to a minimum with the consequence that friction is higher on LTSC low temperature sealing coatings than with the conventional coatings. The LTSC does not stick or block to PBDC or acrylic coatings and hence it is possible to have differentially coated films. The inomer surface has good ink receptivity and does not retain printing ink solvents. Now, the metalizing with aluminum.

Direct vacuum metalizing with aluminum on plastic films results in a significant increase in barrier properties. This is because these films are smooth and a continuous layer of even thickness can be applied. Films treated in this way are PET, polyamide and OPP. The figure it is shown the how the aluminum is coated on the plastic materials. Here the plastic materials are unwind and then it goes to the plating drum where the evaporators the aluminum is evaporated and then it is coated on the or it is attached with the that plastic films to be coated and then it is going and it is again rewind here.

A major cost factor is the time taken to apply the vacuum after a re change. This favors 12 micrometer PET because a large area can be contained in a reel. When applied to PET the film can be used to metalize paper and paper board by transfer from the film using a heated nip roll after which the PET can be reused. The another type of coating which is most commonly used is the SIOX that is the silica oxide. Silica oxide has recently been introduced as a coating.

This material has excellent barrier properties and is applied by vacuum deposition. Silica oxide coated PET film is commercially available and is used in the retard pouch laminates in Japan. It is transparent, retardable, recyclable and has excellent barrier properties. Silica oxide has also been applied to plastic bottles given an oxygen barrier which is 20 times greater than the barrier of an uncoated bottle. The glass skin process introduced by tetra pack also vacuum coats the inside of PET beer bottles.

The DLC coating that is diamond like coating a relatively new coating is known as DLC

or diamond like coating. It comprises a very thin layer of carbon PET bottles do not give as long a self-taught coating as life as glass for the bottled beer market. Here the granules the extruder is used and the thin layer of plastics is coming and it is being coated on the that rolls which are being coated. This is the substrate roll on which the plastic is being coated and then both the things are coming out after coating. DLC coating on the inside of PET bottles has been trailed extensively in Japan extrusion coating with polyethylene.

A heat seal coating can be applied to a heat resistant film such as PET and polyamide by extrusion coating the film with PE that is polyethylene. This is the coating this picture exhibits the coating with polyethylene on the paper board or aluminum film that paper board or aluminum film is passing through this and from the extruder it is coming and then they are coated and then it is going out. The printing and labeling of the plastic materials the first of this kind is gravure printing. The gravure press consists of a series of printing stations in line each applying one color of liquid ink applying cold seal latex or PVDC emulsion in line. A roller is engraved mechanically, chemically or electrically laser eroded into a pattern of a small shells.

This figure depicts that the this roller has got the designs which is to be printed on this paper. So, what is happening this roller is taking the ink from this ink tub and then a doctor blade is fitted to remove the excess ink from the roller and when roller comes in contact with the paper then it printed. These shells hold the ink which is picked up from the ink bath in which the gravure rolls rotates. The amount of ink is controlled by the depth and area of the shell and a doctor blade scraps of the excess ink. Film is passed over the gravure roller with backing pressure from a lay on or impression roll to put the ink out of the shells.

The inked film is passed into a heated oven to dry off the solvents or water medium. Other ink or coating layers are applied in resistor to achieve the finished design. The gravure system allows a very large number of prints as the cylinders are hard wearing and accurately reproduce the design. Initial costs are high due to the engraving process, but for long runs which can be printed at high speed the gravure process is cost effective. The flexographic printing, flexographic printing may be carried out with a number of printing stations in line that is stack space or with the printing rollers arranged around a central large diameter drum that is the central impression.

The plates which are now made from a photo chemical plate material are attached to the printing rolls. Ink is picked up by a cavitated anilox roll and transferred to the printing plates. The ink is then transferred to the film because the cost of producing the plates are relatively low flexographic printing is cost effective especially for short runs. The quality of reproduction has increased and has approached that of gravure printing. The

productivity on both types of press has increased and hence the better choice of process for any given print order has become more difficult.

The digital printing, electronic printing systems have been developed and with coatings available to receive the new ink systems, it is now possible to create art work on a computer and transfer the image directly to the packaging film. A design is created on a computer it may be an individual design or replicated to give several hundreds of impressions. The ink usually in powder form is attracted on the film surface and cured in place. Special coatings are necessary to receive the ink. A standard heat sealable coating on the reverse side allows the film to be made immediately into the package.

The system as yet is only suitable for narrow web widths and is capable of producing test packages for market research or promotional campaigns. The printing and labeling of rigid plastic containers, the first of its kind is in mould leveling. The printed levels can be applied to containers and lids during forming. The technique has been adopted for use in thermo forming for example, yoghurt parts and in both blow moulding and injection moulding for example, ice cream tufts, lids and large biscuit containers. The picture denotes how this printing is done in mould moulding that is the in mould the plastic sheets are there in the mould and then the male part presses this in the female part and then it is injected or blow moulded with the air and then the plastic is that mould is opened and plastic product is ejected.

The designs in relief can be carried out in the walls of the mould. These designs are visible in the moulded item having an embossed or debossed effect. This technique is used to imprint the plastic identification for sorting in waste management schemes indicate the number of the mould and other manufacturers markings. The another type of printing is dry offset printing. This method uses a relief plate which after inking transfers the ink to a blanket roll which in turn applies the design to the plastic surface.

This method has especially been developed to print round and tapered containers. The inks are either heat set or UV cured. Now, the silk screen printing the design to be printed is carried out on a metal or plastic woven mesh. This is placed in contact with the item to be printed and the thick oil based ink is forced or squeezed through in the design areas with the action of a flexible wiping blade. The heat transfer printing the full design is first printed with heat sensitive inks on a carrier web of PET.

This can then be placed in contact with plastic containers at high speed where a heated die transfers the design directly on to the ink. To the container Therimage is an example of a well known form of heat transfer labeling. Heat foil stamping is a type of heat transfer printing. A heat resistant ink with an adhesive coating carried on a PET film is

placed in contact with the item being printed. A heated metal die with the design in relief is pressed against the PET film transferring the image.

This type of decoration can be used to print a high reflective metallic image. Hot foil stamping is often used on luxury items such as curtains for chocolate, confectionery and levels for bottles of spirit and liquors. Thank you very much for today.