

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES TO STUDY EFFECT OF VARIOUS PARAMETERS DURING HEAT SEALING PROCESS OF BLISTER PACKAGING

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ABSTRACT

Various parameters like sealing temperature, pressure and dwell time are of prime significance during heat sealing process of blister packaging. In order to perform the sealing process effectively all these parameters must be proportionate and under control accordingly as a little variation may affect the complete sealing process. Values of these parameters can be adjusted in accordance with the variations in physical - chemical properties of using materials and atmospheric conditions as well. Thus the present study aims to address the effect of various parameters and how the variation in these parameters affect the sealing process on various substrates like folding box board, laminated folding box board, white back paperboard and gray back paperboard coated with a solvent-based coating during heat sealing process.

Keywords: *Blister packaging, heat sealing, lidding material, forming film, sealing parameters.*

I. INTRODUCTION

Heat sealing process is used for various applications in packaging industry to ensure that their products maintain the desired self-lives during the period of storage, transportations and consumptions under specific conditions. Generally four basic components are used for heat sealing process of blister packaging.

- a. **Lidding Material:** -It acts as backing material where all necessary information is printed for informative purposes. It makes a bonding with the forming film with the help of heat seal coating. It is the base materials of the whole blister pack which holds the final product and forming film. Different types of lidding materials used in blister packaging applications are: -
 - Folding Boxboard (FBB)
 - Laminated Folding Boxboard (LFBB)
 - White Back paperboard (WB)
 - Gray Back paperboard (GB)
- b. **Forming film:** - Blister forming film is second most important material after lidding material and broadly includes category of polymer. Films used are PVC (Polyvinyl Chloride) and PET (Polyethylene Terephthalate) depending upon the requirement.
- c. **Printing Inks:** - Inks used in blister packaging are slightly different in comparison with conventional inks. Generally wax free inks are preferred for these applications. Main function of printing ink is to impart information on the substrate.
- d. **Heat seal coating:** - Heat seal coating acts as a bonding agent between the lidding base material and forming film. Solvent and water based heat seal coating are of common use for blister sealing applications.

Objectives of Study

The key objectives of this research are to explicate the following aspects of blister packaging during heat sealing process: -

- i. To study effect of Sealing Temperature
- ii. To study effect of Sealing Pressure
- iii. To study effect of Dwell Time

II. RESEARCH METHODOLOGY

The research work was accomplished to analyze the different aspects of blister packaging during heat sealing process. This research was carried out at Edelmann Packaging India Pvt. Ltd. Baddi (HP). The whole research was made on the basis on testing of the boards under different conditions. First of all various blister board were printed on sheet-fed offset machine by using wax-free blister ink. After that a single coat of heat-seal coating was applied on all sheets and then the sealing operations were performed on all the sheets (FBB, LFBB, WB, GB) with the help of heat sealing machine. The parameters which were taken in consideration included sealing temperature, pressure and dwell time. The data was collected and analyzed.

III. DATA ANALYSIS

During research the collected data was compiled and analyzed in order to conclude a result for the aforesaid research objectives. The results of research are expressed as below:-

1. **Effect of Sealing Temperature:** - The sealing temperature is used to activate the sealant to create a bond between lidding base material and blister forming film for sealing applications having range of 130°C to 160°C. The temperature should be high enough to activate sealant without damaging the surface of the material. Sealing temperature will change according to the change in the lidding base material and forming film and hence different lidding substrates can give a different sealing result at the same temperature. The effect of sealing temperature on FBB, LFBB, WB and GB board is shown as below: -
 - a. **Effect of sealing temperature on Folding Boxboard(FBB):** -During the study the values of two parameters sealing pressure (7dB) and dwell time (3seconds) were kept constant to know the effect of sealing temperature on folding boxboard. Sealing temperature was gradually increased from 130oC to 160oC. The obtained results are expressed in Table 1.

Table 1: Effect of temperature on Folding Boxboard (FBB)

<i>Types of Board</i>	<i>Temperature (°C)</i>	<i>Pressure (Decibels)</i>	<i>Dwell Time (Seconds)</i>	<i>Sealing Result (Fail/Pass)</i>
<i>Folding Boxboard (FBB)</i>	130	7	3	F
	135	7	3	F
	140	7	3	F
	145	7	3	F
	150	7	3	F
	155	7	3	F
	160	7	3	F

During research it was found effective sealing couldn't be achieved in case of folding boxboard on direct surface at any temperature range from 130°C to 160°C, because it has strongly fibers bonding that prevent liquid heat seal coating to penetrate through its cavities. Testing on more high temperature range starts burning of forming film and lidding surface also.

- b. Effect of sealing temperature on Laminated Folding Boxboard (LFBB):** - The results shown in table 2 depicted that laminated folding box board required at least 150°C temperature for sufficient sealing results. Lamination helps to make a bonding between heat seal coating and forming film due to low melting point of PVC which gets dissolved with coating and make a bond with a blister forming film.

Table 2: Effect of temperature on Laminated Folding Boxboard (LFBB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
Laminated Folding Boxboard (LFBB)	130	7	3	F
	135	7	3	F
	140	7	3	F
	145	7	3	F
	150	7	3	P
	155	7	3	P
	160	7	3	P
	165	7	3	F

- c. Effect of sealing temperature on White Back Paperboard (WB):** - White back paperboard is most widely used paperboard in blister applications. This paperboard has loosely fibers bonding as compared to folding boxboard. The results indicated that the sealing was successful in the temperature range of 145°C to 155°C as shown in table 3 when both sealing pressure and dwell time were kept constant.

Table 3: Effect of temperature on White Back Paperboard (WB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
White Back Paperboard (WB)	130	7	3	F
	135	7	3	F
	140	7	3	F
	145	7	3	P
	150	7	3	P
	155	7	3	P
	160	7	3	F

- d. Effect of sealing temperature on Grayback Paperboard (GB):** - Finding expressed that good sealing strength was obtained at lower temperature 140°C as shown in table 4. Because gray back paperboard has loosely fiber bonding as compared to WB and FBB board, hence gets good sealing strength.

Table 4: Effect of temperature on Grayback Paperboard (GB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
Grayback Paperboard (GB)	130	7	3	F
	135	7	3	F
	140	7	3	P
	145	7	3	P
	150	7	3	P
	155	7	3	F
	160	7	3	F

2. **Effect of Sealing Pressure:** - The sealing pressure is required to ensure that the film surfaces are in contact with the lidding material for interfacial penetration. The effect of sealing pressure on FBB, LFBB, WB and GB board is shown as below: -

- a. **Effect of sealing pressure on Folding Boxboard:** -Variations in pressure couldn't make a change in the result during sealing process when it was up to 9dB for folding boxboard. When pressure was increased during heat sealing process for folding box board the sealing result remained same as expressed in Table 5.

Table 5: Effect of pressure on Folding Boxboard (FBB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
Folding Boxboard (FBB)	130	7.0	3	F
	130	7.5	3	F
	130	8.0	3	F
	130	8.5	3	F
	130	9.0	3	F

- b. **Effect of sealing pressure on Laminated Folding Boxboard:** - When different ranges of sealing pressure were used for laminated folding boxboard with ideal values of others parameters (Sealing temperature, Dwell Time), then it affected the final sealing strength. The results are expressed in table 6. The results indicated that when pressure was below 6.0 dB then heated liquefy coating failed to make a proper bonding with the forming film. Also when pressure was set up above 8.0dB, it squeezed out of the molten film from the sealing area. Pressure ranges6.0 to 8.0 dB was ideal toobtain good sealingresults.

Table 6: Effect of pressure on Laminated Folding Boxboard (LFBB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
Laminated Folding Boxboard(LFBB)	155	5.0	3	F
	155	5.5	3	F
	155	6.0	3	P
	155	6.5	3	P
	155	7.0	3	P
	155	7.5	3	P
	155	8.0	3	P
	155	8.5	3	F
	155	9.0	3	F

3. **Effect of Dwell Time:** - Dwell time is the actual time when lidding base material and blister forming films are brought in contact by heating bars. Inmodern blister packaging industry, the dwell time is in the order of fractions of a second or in some cases 3-5 seconds. The optimum dwell time guarantees no excessive time is wasted to keep up the production speed. Dwell time may be different with the change in the using materials and by the variations in the others parameters. The effect of dwell time on FBB, LFBB, WB and GB board is shown as below: -

- a. **Effect of dwell time on Folding Boxboard:** - Change in the dwell time couldn't help to make a change in the sealing strength for the folding box boxboard. Whendwell time was increased gradually from 3 to 6 seconds maintaining temperature and pressure constant, the end sealing results remained same as shown in Table 7.

Table 7: Effect of dwell time on Folding Boxboard (FBB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
Folding Boxboard (FBB)	130	7.0	3	F
	130	7.0	4	F
	130	7.0	5	F
	130	7.0	6	F

- b. Effect of dwell time on Laminated Folding Boxboard:** -During the study it was found that when dwell time was increased from 4 seconds to 5 seconds, the sealing result was successful for laminated folding boxboard at 130° C temperature and 7.0 dB sealing pressure as shown in table 8.

Table 8: Effect of dwell time on Laminated Folding Boxboard (LFBB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
Laminated Folding Boxboard (LFBB)	130	7.0	3	F
	130	7.0	4	F
	130	7.0	5	P
	130	7.0	6	F

- c. Effect of dwell time on White Back Paperboard:** - The results for the effect of dwell time on white back board are expressed in table 9. During the study it was found that there was successful sealing at the dwell time of 4 and 5 seconds when 130° C temperature and 7.0 dB sealing pressure was maintained.

Table 9: Effect of dwell time on White Back Paperboard (WB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
White Back Paperboard (WB)	130	7.0	3	F
	130	7.0	4	P
	130	7.0	5	P
	130	7.0	6	F

- d. Effect of dwell time on Grayback Paperboard (GB):** - The results for the effect of dwell time on gray back paperboard are expressed in table 10.

Table 10: Effect of dwell time on Grayback Paperboard (GB)

Types of Board	Temperature (°C)	Pressure (Decibels)	Dwell Time (Seconds)	Sealing Result (Fail/Pass)
Gray back Paperboard (GB)	130	7.0	3	F
	130	7.0	4	P
	130	7.0	5	F
	130	7.0	6	F

According to the results tabulated in table 10, when the dwell time was increased from 3 to 4 seconds there was successful sealing at 130 °C temperature and 7.0 dB pressure. Further increase in dwell time made the burning/melting of paper surface while sealing.

IV. RESULTS AND CONCLUSION

During the analysis the effect of various parameters i.e. sealing temperature, pressure and dwell time were studied on different kinds of sheets which included Folding Boxboard (FBB), White Back paperboard (WB), Gray Back paperboard (GB) and Laminated Folding paperboard (LFPB) while performing heat sealing operations during blister packaging. During the research it was observed that sealing couldn't be achieved on folding box board without PVC lamination due to its strong fiber bonding. Also the importance of sealing temperature cannot be neglected. Sealing pressure plays a crucial role in order to ensure the physical contact between lidding materials and forming film. Variations in sealing pressure couldn't affect the value of other parameters but affected the final sealing strength of the package. The obtained results also indicated that when dwell time was increased gradually from low to high then sealing temperature simultaneously decreased. Hence both parameters i.e. the sealing temperature and dwell time are inversely proportional to each other.

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