STATIC AND STATIC CONTROLS IN PRINTING

The problem of the control of static electricity charges is of increasing importance in the printing industry. This problem has been with the industry almost since the first power press. Since that time, nearly every conceivable theory developed for control of the problem has been tried with varying degrees of success. For many years, it has been the cause of variations in printing quality and volume of output over which little control has been exercised. Finally, it was accepted as a necessary evil in the industry. With increasing speeds of modern presses, and with the constant pressure for higher volume and better quality output, the problem of static control has grown beyond the "nuisance" level, and is now recognized as a costly problem that has to be solved if full profits and earnings are to be attained. Any improvements which reduce or eliminate static impairment in the printing industry are highly desirable. Operations personnel and printing engineers are giving major attention to this problem.

The information given in this report is intended to give the printer a better appreciation of when static conditions are causing production and quality problems, and to indicate some of the methods by which the problem of static control can be minimized.

THEORY OF ELECTRO-STATIC CHARGES

The generation of static electricity has long been thought to be purely a frictional phenomenon. However, the words "Contact" and "Separation" may more accurately describe the mechanism by which "static" is generated.

When two uncharged materials are placed or pressed into intimate *contact* with each other, the surface electrons of each material at the points of *contact* have a tendency to mix with each other, and to assume a different arrangement than they normally possess in the individual materials. If the two materials are then *separated* rapidly by sliding one on the other, or pulling one off the other, the displaced electrons have difficulty redistributing themselves into their normal arrangement. This is particularly true when one, or both of the materials are insulators or poor conductors of electricity. This separation will leave one of the materials positively charged and the other negatively charged.

Normally, uncharged materials have an equal number of electrons (negative charges) and positive charges in each molecule of the material. The negative charges (electrons) are the only movable charges. The positive charges are fixed in position. Therefore, if you take electrons away from a material, it is left positively charged. If you add electrons to a material, it becomes negatively charged.

A negative charge (or a negatively charged material) will repel another negative charge (or another negatively charged material). The same is true of two positive charges (or a pair of positively charged materials). This is just like the case of two magnets where the north poles will repel each other as will the two south poles.

However, a negative charge will attract a positive charge, just like the north pole of one magnet will attract the south pole of another magnet.

This is what we mean by the old axiom of electrostatics: "Like charges repel; opposite charges attract".

Knowing this, we can see why some static charged piles of paper seem to "float" in the jogger of a printing press, and why some act as if the sheets were glued together.

There are many reasons why the severity of static conditions varies. Sudden changes in climatic conditions will frequently cause static to flare up suddenly without apparent reason. It frequently will be noticed that static is severe on a day before a heavy storm when the barometric pressure is low, or after a storm has passed by when a period of low temperature and low humidity prevails. It also has been observed in the summertime after thunderstorms have charged the atmosphere. Static conditions have even been tied into variations in cosmic discharges from the sun. When all these variables are included with the basic conditions causing static; i.e. friction and pressure, it is little wonder that a great deal of confusion exists in deciding on the most effective ways to control static.

There is another variable involved. Differing types of material have what is known as differing dielectric strength. For example, a sheet of plastic material such as cellulose acetate or vinylite, has a much higher dielectric strength than has paper. Similarly, nylon, yarn, and fiberglass yarn, have a greater dielectric strength than cotton or wool. What this means is that static forms more readily on material such as vinylite and cellulose acetate than on, say, paper. The reason for this is that the moisture regain potential is fairly high, then with the absorption of moisture the material in question becomes more conductive to static electricity and less of a problem.

In the printing field particularly, the weight of the paper is a major factor in determining the extent to which static causes trouble. Actually, no one cares particularly whether there is static present in the printing operation except in so far as it hurts the appearance of the printed sheet or cuts down on the output. With light grades of paper, static charges show up more quickly than on heavier paper so that the same amount of static causes greater trouble. Also some types of paper are more susceptible to static impairment than other varieties.

There is, therefore, an almost limitless number of variables in the picture as concerns the existence of static, the causes of static, and the cost of troubles caused by static.

HOW TO TEST FOR STATIC

Many instruments have been devised to measure static quantitatively. The portable hand held, static locators and static meters are the most commonly used. These hand held field meters can be used to detect and measure static voltages and indicate their polarities. Generally, these meters cost between $300.00 and $1,000.00.

There are many different operating tests for static, however, that can be used in the field which will, in most cases, provide sufficient information to evaluate static problems in the printing industry. For example, on the delivery pile, when one sheet is lifted slightly at the edge and then pulled away from the pile, if there is static present, the second and third and fourth sheets will tend to drag off the pile with the first sheet. When static is not present, however, the first sheet will pull off easily and cleanly without any pull against the lower sheets. Another test to determine whether static is present in the feeder pile or in the delivery pile, is to take a fluffy piece of string or yarn six to eight inches long and hold this string near the sheet material on the pile. If static is present, the string will be strongly attracted to the material. A string can thus be used to locate the rolls, for example, where static is being generated, or the locations where static is the cause of operational difficulties.

TROUBLE CAUSED BY STATIC

Although there is a great deal of confusion regarding the causes of static impairment in the printing industry, the operating difficulties that it causes seem to be pretty well agreed upon:

PRINTING PRESS

- **Poor Feed & Register**:
  On printing presses, static frequently causes trouble on the feeder (particularly with light weight paper) in that the static attraction between the sheets will cause the feeder to pick up two sheets at one time rather than a single sheet. It also causes trouble on the feed board in that as the sheet of paper moves down the feed board, it may be attracted to the press, causing the sheet to turn slightly sideways. This gives either poor register or trips the stopping mechanism on the press and stops the press.
- **Poor Jogging**:
  A site of possible static trouble is on the delivery where poor jogging of the printed sheets may require hand stacking of the pile in order to permit either a re-run of the paper through the press for another color, or to permit trimming of the sheets. Where this condition occurs, two or more sheet stackers may be required to properly jog the pile.

- **Excessive Offset**:
  A defect caused by static may be excessive offset conditions. Frequently the paper or the pressman or the ink is blamed for offset when, in reality, the attraction of one sheet of paper to the next, caused by a static charge, may be the underlying reason why a serious offset condition has occurred. Not all offset troubles should be laid at the doorstep of static, but if static conditions are present, even though the other factors such as paper and ink are satisfactory, offsetting may still occur and be entirely beyond the power of the press operator to eliminate except by slowing down the press.
- **Retard Drying**:
  Static conditions on the delivery pile will seriously retard drying of the printed sheet because the air "cushion" between each sheet when static is not present, is squeezed out when static conditions attract one sheet to the next.
- **Tracking**:
  A defect which is less common is the so-called static "tracking" of the ink on the printed sheet. This occurs when static is present on the sheet and light or volatile inks are used. In this case, the ink fans out from the impression in the form of tiny feathers or crows feet. This is of course a major quality defect. The problem is more common in the gravure field, but it also occurs in letter press printing. Another problem on gravure presses is the fire or explosion hazard caused by static. Using the highly volatile inks required means that an arcing discharge spark caused by static may easily result in a fire. On some types of gravure presses which use a totally enclosed fountain, the danger of fire is less, but the totally enclosed feature permits the vapor to gather in explosive, rather than in flammable, concentrations. Therefore, if there should be an arcing discharge because of static within the ink fountain, an explosion may occur.
- **Dust Attraction**:
  The paper dust resulting from slitting, cutting or trimming operations, may be attracted to the sheet. When this sheet runs through the printing operation with the dust on it, the finished work will not be top standard, and may cause rejection of the finished job by the customer. It is important, therefore, that some method for removing this dust from the sheet before printing, be found. Since the static charge causes the dust to be attracted to the sheet, brushing or suction in itself will not remove this dust satisfactorily, and the use of static control equipment is indicated to release the dust so it may be removed from the paper.

FOLDERS
In addition to static troubles on presses, static control equipment is frequently necessary to properly operate folding machines. In this case the paper may come from the presses loaded with static which of course causes trouble on the feeder. More frequently, however, static builds up on the sheet going through the first fold to such an extent that the sheet sticks after coming out of the first fold and will not go properly into the second fold. Trouble is also experienced in the final delivery with the folded sheet being attracted to the next sheet and sticking together to give poor jogging.

RULING MACHINES
On ruling machines, static is frequently a severe and expensive problem. In this case, not only does the sheet tend to stick and jam on the machine, but the static attraction of the sheet to the machine gives uneven ruling. The sheets also tend to jam up at the delivery.

SHEETERS
The fourth type of machine in the printing industry where static conditions frequently cause major quality or production impairment is on the big paper sheeters. These machines are used more extensively in the paper mills; however, enough printers have these sheet cutters in their own shops to justify discussion of the problem in this report. It is on these big sheeters that static conditions are most severe and most difficult to solve. The reason for this is that the sheeters frequently cut eight, ten, or twelve rolls of paper at a time, and then use over-riding tapers on the lay-boy so that as many as thirty six sheets are pushed into the delivery box at one time. Static causes trouble on these sheeters at the cutting knife by causing the sheet to ride right around the cutting cylinder after the knife, and

jamming up the whole cutting process. Static is also caused by the sliding of the different layers of paper on the overriding tapes. Since this static is generated between the sheets, it is very difficult to get at, and to remove it. However, any improvement in the performance of these big production machines is very valuable to the printer as poor delivery of the sheets into the delivery box means hand stacking of the sheets. This very quickly adds up to a major, additional expense, to be avoided if possible.

The foregoing summarizes the various types of static problems that are encountered in the printing industry. Undoubtedly other types of static impairments have been encountered in the industry which are not discussed here. In this connection one precautionary note should be sounded: **There are times when static is blamed for the poor performance of a press or other type of machine when, in fact, some mechanical operation needs adjustment. When this occurs, all possible causes of the difficulty should be investigated.**

WHAT STATIC IMPAIRMENT COSTS THE PRINTER

The extent and cost of static impairment to the printer both in production volume and in quality, is not generally recognized. This is due partly because of the traditional attitude that "static has always been with us and there is nothing we can do about it". A more important reason is that because so few records are kept which analyze the reasons for "down time", or for lowered production, or for waste. That static is a real cost to the printer however is gauged by his reaction when asked the question as to what it would be worth to him to improve either the quantity or the quality of his output by 4 or 5% without any increase to him in labor cost or overhead charges and with practically no increase in operating and maintenance expense. The reason for this positive response is that an increase like this in gross (without corresponding increase in expenses) means a sharp increase in net profits. Of course, under certain conditions, and using certain kinds of paper, the extent of the static impairment is greater than 4 or 5%. The statement has frequently been made that "there is no other single accessory that can be installed on a printing press or other type of machinery in the printing industry that would increase net profits as much as an effective instrument for the control of static electricity". With a constant pressure against the printer to step up the output from his presses, and with competitive conditions returning to the industry, it is little wonder that so much effort is being made to control static in printing operations.

METHODS OF COMBATING STATIC

There are several generally accepted methods for combating static in printing operations. These methods are of varying effectiveness and popularity. Some concerns use no equipment at all to control static, but when conditions are severe, they either slow down the speed of their presses, or employ additional personnel to handle the sheets by hand. All of the methods discussed below are effective to some extent in the control of static electricity. The degree of the static impairment, is the critical test of the value of the particular method adopted.

Steam

A more or less makeshift method, which is sometimes effective, is to install steam jets which shoot live steam in at the location of the difficulty. Live steam provides a pathway over which the static charge may flow from the paper; however, this method is frequently in disfavor because of the tendency of the steam to rust machine parts, while, in addition the steam makes the room uncomfortably hot and humid and is expensive to operate. Further, this method may interfere with the quality of the finishes product.

Preconditioning

One method that is sometimes used is preconditioning the paper for a period of three to four weeks before bringing it into the press room. Using the preconditioning method, the paper is kept under the same heat and humidity conditions as obtained in the press room. Then, when the paper is ready to be used and brought into the press room, there will not be, hopefully, any sharp change in moisture or temperature to cause static to flare up. This method is fairly satisfactory where space limitations do not prevent the storage of the paper right in the plant, and where the additional cost of heating and humidification of the storage area is not great.

Humidification

Some plants that are completely air-conditioned and humidified have found their static condition reduced in intensity from those of non air-conditioned plants. It is interesting to note, however, many air-conditioned plants have static control equipment installations on their presses so that air-conditioning in itself is not the complete answer to the problem. In this connection, certain completely air-conditioned mills in the textile industry have found that they have been able to substantially reduce the relative humidity in their mills after the installation of effective static control equipment. Since it costs nearly as much to humidify as to heat a given area, a reduction of ten points or so in the relative humidity gives a real savings in operating costs. It also has been noted by these mills that a variation of even 5% in the relative humidity in a plant can cause static to flare up. It is, of course, very hard to keep the relative humidity within a variation of less than 5%. However, within the limitations set out above as to effectiveness and cost, air-conditioning and humidification does represent a way to reduce the static problem.

Anti-Static Chemicals

Anti-Static Chemicals are another means of static control and are frequently used. Supplied in aerosol cans, pump bottles, or in bulk, these Anti-Static Chemicals can be dipped, wiped or sprayed, whichever is most suitable for the application. Using "hygroscopic" agents, the purpose of the Anti-Static Chemicals is to allow the treated surfaces to attract and absorb moisture from the air, forming a minute layer that is (static) electrically conductive.

Anti-Static Chemicals are most commonly used as a stop-gap measure where only occasional static problems arise or where other conventional static eliminators are not feasible. One drawback of Anti-Static Chemicals is that in printing operations they may have to be frequently reapplied in order to maintain their effectiveness.

Although Anti-Static Chemicals cannot solve all static problems, such as static generated between sheets of material being processed, they lend themselves as a valuable tool in static control.

Ionization

A fourth method of static control, and most widely used, is ionization. Ionization is the process by which air molecules are broken down into ions of both positive and negative charges (an ion is an atom or molecule which is electrically unbalanced). The generated positive and negative ions interact with a static laden surface in such a fashion to reduce or completely neutralize the static charge (by returning the static charges to electrical balance), whether it be positive or negative. Ionization for the purpose of static elimination is typically achieved by using the following three methods:

- **Induction**:
  Ionization through induction involves bringing electrically grounded sharp metal points, usually made of copper or brass, in close proximity to a moving static-laden surface. An interaction between the electrostatic field, always present with static electricity and the sharp end of the metal points, initiate and maintain an ionization process in the surrounding air, thus acting to neutralize the static charges. The most commonly used induction type device is copper static eliminating tinsel.

  The three most evident limitations of induction type devices are: a) the device must be kept in close proximity, usually within 1/4", to the static laden surface in order to be most effective, b) the inductive device requires a threshold voltage (usually considered to be approximately 2000 volts) to maintain the ionization process. Below this threshold voltage the induction device will cease to function and, thus, will not reduce the static charge below this point. (Note: Threshold voltages will change with factors such as changes in humidity and temperature), and c) in the case of copper tinsel and similar devices, oxidation, dust, ink, and similar contaminates require it to be replaced periodically.

  On the other hand, induction devices are a low cost method of static elimination and in many applications can reduce static charges to an acceptable level.

- **Radioactive**:
  Radioactive static eliminators use low grade radioactive elements, usually polonium 210, to create a static eliminating ion field. As a result of the decaying radioactive elements in the static eliminator, high speed alpha particles are emitted, bombarding surrounding air molecules, creating both positive and negative ions.

Radioactive eliminators are most commonly used where a completely self contained device (one without external power cables or power supply) is desirable or for explosive atmosphere or for applications that require a light free device (such as photographic film processing).

Radioactive eliminators can only be secured through a lease arrangement due to the fact that they have to be returned to the manufacturer for testing and replacement of the radioactive element which normally has a half life of one year. Annual replacement and high lease charges sometimes make these devices undesirable for typical applications.

- **Electrically Activated**:
  Electrically activated static eliminators operate at voltages from about 1500 volts to 18,000 volts. Ionization is achieved by impressing high voltage on the sharp points of one or more metal emitters that are in close proximity to electrically grounded targets or electrodes. Because of the difference in electrical potential between the emitter and grounded targets, the air surrounding the emitters breaks down into both positive and negative ions.

  Electrically activated eliminators can be found in several different configurations including: Static Eliminating Bars, Ionizing Air Guns, Nozzles, and Static Eliminating Blowers (fans). Although competitively manufactured electrically activated eliminators vary in their performance, a well designed eliminator should be able to eliminate static charges at any level or speed that is typical in the printing industry. A good criteria for evaluating the performance of an electrical eliminator or radioactive eliminator is its effective gap range (gap is the distance from the emitters to the static laden surface). The higher the gap range the higher the output of the eliminator.

  In addition to performance, there is one other major difference between types of electrical static eliminators, that is "shock" or "hot" verses "shockless". These terms relate to the electrical current output of the emitters. The "shockless" eliminators resist the current supplied to the emitter to the point where it is nearly undetectable by the human touch. "Shock" or "Hot" eliminators normally resist the current below the dangerous level, however, when coming in contact with the emitter a mild to vigorous shock will be experienced, depending on the make. Although "shock" type eliminators are normally considered safe, personal discomfort and secondary hazards, as a result of possible shock situations, may be worth considering when purchasing static control equipment; especially when it is mounted near a machine operators work area.

  Successfully engineered static control installations of proven merit have been worked out for most of the leading makes of printing presses, rulers, folders, and sheeters now being made.

IN CONCLUSION

Uncontrolled static electricity has been, and is, a costly problem in the printing industry. A problem that printers, engineers, and management need to be aware of. And once recognized, steps should be taken to incorporate proven methods of static control, if the goals of higher quality, production, and profits are to be achieved. It is our hope that this report will assist in these goals.

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