Improved methods for packaging copy paper with hot melts

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ABSTRACT: Unintended contamination of copy paper with hot melts used in packaging may cause substantial trouble in modern high-volume copiers. Three practical and effective solutions that prevent such contamination are safe hot melts for ream packaging, heat-seal methods for reams, and a new type of box packing that uses new hot-melt glues.

KEYWORDS: Boxes, copying papers, heat sealing, hot melts, impurities, packaging, polyamides, reams, wrappers.

Modern high-volume copiers and sheet printers, which consume the majority of today's cut-sheet office paper, have become quite reliable machines. Jamming rates are in general rather low. Intrinsic lifetimes of principal supplies, such as photoconductors, are nowadays as much as 500,000 copies. Statistical feedback from the market discloses, however, that the intended high performance of copiers is often jeopardized by unintentional machine contamination from paper sheets with hot melts, used to fasten the customary wrappers of paper reams. Typically, drops of glue and angel-hair-like glue fragments are found on the top sheet or on the shorter sides of the paper pile in the ream interior. As xerographic copiers use heat and pressure to fuse the toner image, the lower fusing hot-melt glues, once fed into the copier, can stick and split to various copier parts and interfere with normal copy processes. Repeated paper jams, copy quality defects, and photoconductor pollution are common complaints. Extra maintenance visits to clean the copier or replace affected parts are the result. These phenomena have been reported on a regular basis in recent years *(1–3)*.

Statistics

The annual market volume of copy paper is estimated to be around 2.8 million tons in the United States *(4)* and 2.2 million metric tons in Europe *(5)*. Practically all this paper is distributed in standard reams of 500 sheets each.

The author and his co-workers decided to measure the frequency of occurrence of hot-melt fragments on the paper sheets. The ream samples were randomly selected from eight original paper manufacturers in the United States and 15 in Europe, representing over 70% of the cut-sheet supply in each market.

These tests were performed by running the paper through a fully operational high-volume copier and collecting glue fragments at a specifically designed machine part. The number of glue spots was counted at regular intervals. The results are given in **Figs. 1 and 2,** judged to an arbitrary limit of five major defects per 1000 reams (equals one defect per 100,000 sheets). Only those fragments with a diameter of more than 1 mm and angel-hair structures longer than 10 mm were counted.

Current ream packaging processes and procedures

Machinery for industrial packaging of cut-sheet office paper in reams is supplied by only a few companies worldwide *(6)*. The application of the hot-melt glue on the wrapping paper occurs mainly by blade-dosed rotating wheels, as well as through pressurized nozzle-jets. In the 24-hour-a-day, year-round operations of many converting plants, neither system has been shown to provide foolproof operation with respect to glue handling. The occurrence of defects, as indicated above, was fairly equally spread over the machinery of the various suppliers.

Clearly defined and strictly maintained operating and cleaning procedures in the converting area are imperative to achieving or maintaining high-quality packing standards. Recently, several new improvements have been proposed by packaging ma-

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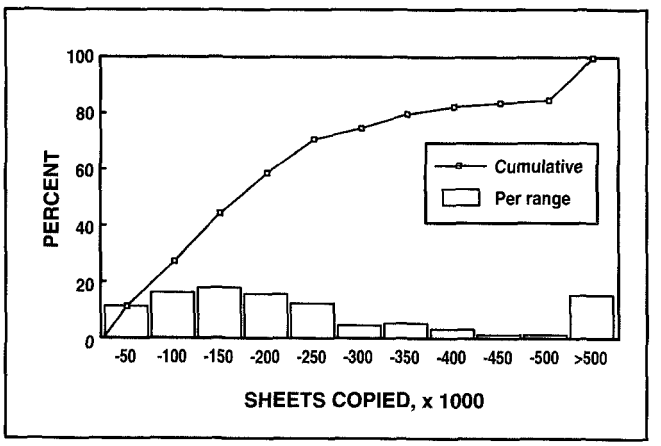
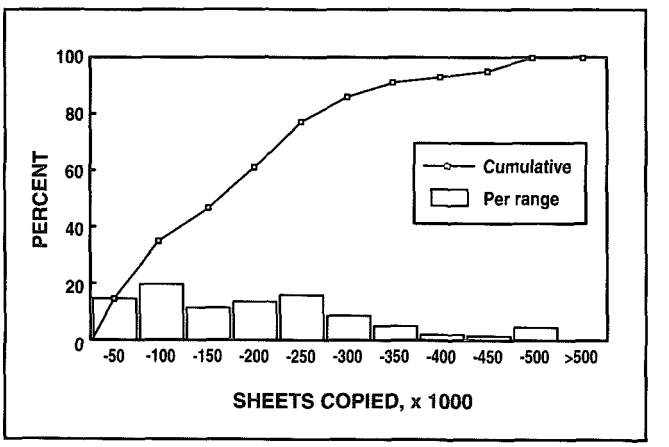
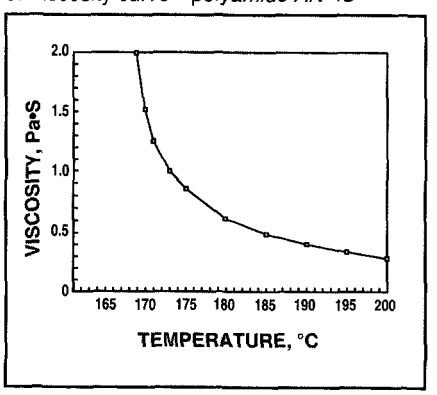
1. Glue contamination on copy paper produced in Europe—statistical chance to exceed 5 defects/1000 reams



2. Glue contamination on copy paper produced in United States—statistical chance to exceed 5 defects/1000 reams



3. Viscosity curve—polyamide AN-48



chine manufacturers to ease glue control tasks for the converting operators.

Some U.S. paper mills are now using brightly colored blue and orange hot-melt glues. This makes glue pollution easier to detect and correct during the packaging stage and helps the copier operator detect and reject contaminated sheets during loading.

Novel ways to pack copy paper with improved quality

Recent developments within the industry have led to new technical methods that eliminate hot-melt contamination and its negative effects. These methods address the problem at the root and do not require drastically altered working procedures or intervention by individual copier users. Three of these new developments are described below.

Hot-melt glue with higher fusing temperature

Solid toners, used in electrophotographic processes, usually have glass transition points between 50°C and 60°C and melt to visco-elastic fluids that fuse onto paper at temperatures between 90°C and 135°C. Pollution problems arise with glues that melt at considerably lower temperatures, as is the case with many ethylene-vinylacetate, polyethylene, and polypropylene-based glues. However, if hot-melt compounds are used that have visco-elastic fusing temperatures higher than common toners, no harmful pollution of copier parts will occur, not even in the case of actual paper contamination.

A new option, proven on a large scale in Europe, is to use higher temperature, heat-stable polyamide hot-melt glue. Of course, a corresponding higher temperature setting in the packaging process is required. These hot melts are compatible with common jet application nozzles and wheel applicators. For optimum use at the higher temperatures, stringent temperature control is advisable. A typical example of a high-temperature hot melt is polyamide AN-48, with melt characteristics as indicated in **Fig. 3.**

Heat-seal process for paper reams

With the objective of maximizing moisture prevention (through complete closure of reams) and preventing glue pollution, two types of heat-sealed reams were introduced in 1992.

One type applies very thin lines of heat-sealable glue simultaneously with the printing of the ream design on the outside of the wrapping material. This can be done with a flexo print process, for instance. The glue is later reactivated by heat in the packaging machine. This process requires registered ream wrapping.

In another type of heat-seal product, seams in the length are sealed by heat activating a carefully selected polyethylene wrapper coating, which also provides the required moisture protection. In this option, the seams in the width are glued with safe hot melt of the type mentioned above.

Both methods have been proven to fully prevent damage by glue contamination. Additionally, both promote better control of the gluing process, which means less glue can be used. This may well compensate for the higher cost prices of these special adhesives.

Box packing without ream wrappers

In January 1993, a new packing method was introduced: namely, the long-awaited method *(7)* of packing 2500 sheets of paper in a cardboard box without any interior wrapping. This offers users of high-volume copiers substantially higher productivity while at the same time eliminating a great deal of waste material with, most likely, lower running costs. This method, requested by paper mills and several manufacturers of high-volume copiers, can now be applied on an industrial scale using newly designed machinery. The boxes themselves are still glued together, but all measures are taken to ensure the standard use of safe hot-melt glues, such as the above-mentioned polyamide type, preferably combined with removable (peel-off) linerboard.

Based on experiences in a field acceptance test that the author and company co-workers conducted in 1990 with similar, yet still hand-packed boxes, this packing could well become a new, important standard for high-volume users. It offers a new option for people who produce more than 100 copies/min and wish to circumvent the "time-honored" tradition of unpacking reams of paper every few minutes. The ream packing system was invented some 50 years ago, when copiers averaged 10 copies/min.

Discussion

The "right" choice of adhesive systems or hot melt with the various effective packaging methods will depend on functional, economic, safety, and environmental factors. Positive aspects are:

- Hot melts generally allow for the high industrial scale production of packed paper
- Neither of the glues discussed presents any safety risks.

Negative aspects with conventional hot melts are:

- The above-mentioned damage to copiers with subsequent repair requirements
- Problems occurring with recycling of hot-melt-containing waste wrappers.

In a cradle-to-grave approach, economic and especially environmental aspects of safe hot-melt glue offer additional insights.

If glue defects would cause copier service calls at the frequency of the aforementioned limit value, the energy balance ratio between either "performing the service call in the field" or "preventing calls by using a safe hot melt" is 1 to 753 beneficial to the latter option (just for the driving; no supplies taken into account yet). Similarly, the cost balance would be advantageous with a ratio of 1 to 250. These figures are based on the following assumptions:

- Estimated use of 2 L of gas per call for driving to customer. Combustion heat Hexane 31,900 kJ/L.
- Extra heat consumption for operating glue at 100°C elevated temperature is 418,4 kJ/kg. Glue consumption: 1 g/ream.
- Call after 100,000 copies. Cost of one service call: US$ 200. Extra cost: glue US$ 4/kg (<0.1% of paper value).

Additionally, it was shown that the indicated types of polyamide hot-melt glues do not form stickies in boiling water but rather remain inert. This may ease the recycling process of these materials considerably. Apart from the costs associated with removal of stickies from recovered paper, the presence of nonrecyclable materials in the office paper waste drastically reduces its value and thus its potential use in recycled paper products *(8)*.

Conclusion

Today there is no justification for hot-melt polluted copy paper, not for technical, economic, or environmental reasons. ◧

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The author wishes to express his thanks to K. van Leeuwen, Adley Hot Melts, The Netherlands; K. Haasemann, Pemco Inc., U.S.A.; J. Cousquer, Aussedat-Rey, France; G. Kerkstra, Berghuizer Papier, The Netherlands; and J. Beckers, Océ-Nederland, for their contributions to the novel methods described; and to F. Stadler, Océ-Bruning, U.S.A., and F. Voet, Océ-Nederland, for testing the papers.

Received March 4, 1993.

Accepted May 12, 1993.

Presented at the TAPPI 1993 Hot Melt Symposium.