IBM IR QUALITY ENGINEERING LABORATORY BÖBLINGEN

Title: COEFFICIENT OF FRICTION (STATIC AND KINETIC) 7 AND 9 POINT CARD STOCK

# 1.0 INTRODUCTION

## 1.1 SCOPE

1.1.1 This document establishes the method for determining coefficient of friction (static and kinetic) of 7 and 9 point card stock.

1.1.2 Coefficient of friction may be generally defined as a ratio of the horizontal force required to move a given object in a horizontal plane to the weight of the object moved. Specifically, it describes the relative ease with which one data processing card may slide over another.

## 1.2 REFERENCES

### 1.2.1 Specifications

1.2.1.1 IBM-IRD 7-02-0101 -- Card Stock IBM Information Processing Cards

1.2.1.2 IBM-IRD 7-02-0201 -- Card Stock 9 Point Data Processing

1.2.1.3 IBM 894502 -- Data Processing Card Stock 7 Point

1.2.1.4 IBM 894507 -- Data Processing Card Stock 9 Point

### 1.2.2 Standards

1.2.2.1 TAPPI T-402 05-49 -- Conditioning Paper and Paperboard for testing

## 1.3 AUTHORIZATION

1.3.1 This document is authorized by the Manager of IRD Quality Assurance.

1.4 TEST EQUIPMENT/MATERIAL

NOTE: The data processing card stock friction testing machine has been designed to effectively measure the force required to slide one card over another under a specific weight. In accordance with the general formula, the ratio of the horizontal force to the weight becomes the coefficient of friction. For ease in computing the coefficient of friction, the weight has been made to equal 1000 grams (see Figure 1.).

1.4.1 The data processing card stock friction testing machine, IBM part no. M-8331, is a spring loaded, motor driven, horizontal push gauge calibrated into a 1000 gram units scale functioning over a card friction table, type of instrument. The assembly consists of the following component parts, illustrated in Figure 1. (a) power switch, (b) spirit level, (c) level adjustment knob, (d) operating lever, (e) card table, (f) 1000 gram weight, (g) 1000 gram scale and (h) 1000 gram weight stop. Refer to drawing.

1.4.2 300 Gram Weight

1.4.3 450 Gram Weight

1.4.4 Nylon monofilament line

1.5 CALIBRATION (See Figure 1)

1.5.1 Place the data processing card stock friction testing machine in an upright position on a well supported flat surface such as a laboratory test table or a sturdy work bench.

1.5.2 With operator facing front of machine, operating lever (d) must be in the extreme right position while the power switch (a) should be in the OFF position on the machine.

1.5.3 Insert electric plug in 110 (220) volt A.C. outlet.

1.5.4 Turn level adjustment knob (c) to right or left as is required until spirit level (b) indicates that the card table (e) is in a level, horizontal position.

1.5.5 Throw power switch (a) to ON position. Position of operating level (d) at extreme right will cause the motor to drive the

1000 gram scale (f) to the extreme right where it will stop at the limit of its travel. The data processing card stock friction testing machine is now ready for operation.

1.5.6 Tie a short piece of nylon mono filament line to a 300 gram weight.

1.5.7 Place the weight perpendicular to the pulley and run the mono filament line over the pulley and attach it to the hooked end of the push-pull gauge shaft. The mono filament should be taut and so positioned on the hook that it is in direct line with the shaft. The weight should be positioned so that it is lifted without lateral movement when machine is activated by moving lever (d) to the left.

1.5.8 Ensure the gram scale indication is positioned at zero or below.

1.5.9 Activate the machine and record the reading. (Should be 300 grams -- which is the lower limit of the specification).

1.5.10 Using a 450 gram weight, repeat 1.5.6 through 1.5.9 to get a reading for the upper specification limit.

1.5.11 If the scale readings are not 300 and 450 grams when tested with the corresponding weights, the push-pull gauge should be adjusted by rotating the knurl knob at the left end of the gauge. When proper adjustment has been made, the knurl knob should be secured in place with tape so that it does not change position accidentally. Calibration is now complete.

NOTE: The friction tester should be calibrated at least every three months.

## 2.0 PROCEDURE

### 2.1 SAMPLE PREPARATION

NOTE: Refer to applicable specification (Reference 1.2.1) for actual value(s) to be tested.

2.1.1 The test sample shall consist of eleven consecutive standard data processing cards (unprinted).

2.1.2 These cards should not be handled any more than is absolutely necessary.

2.1.3 Environment for conditioning testing each test specimen shall be in accordance with TAPPI T-402 05-49. (73 ± 3.5°F and 50 ± 2% R.H. for a minimum of two hours.)

## 3.0 TEST INSTRUCTIONS

3.1 Insert the well stacked group of eleven cards with wire face down on card table (e) and with the No. 1 column of the card located nearest the scale. Refer to drawing.

3.2 Slide the top card toward the right until it projects about 1/3 its length over the remainder of the eleven card groups where it will come to a halt and rest upon the group of cards as it comes in contact with the 1000 gram weight stop (h).

3.3 Place the 1000 gram weight (f) on top of the card group and against the 1000 gram weight stop (h). The vertical bar and guide on one side of the 1000 gram weight must fit in the corresponding notch provided in the 1000 gram weight stop (h).

3.4 Move the operating lever (d) to the extreme left as is shown in Figure 1. The 1000 gram scale (g) will then begin to operate by moving toward the left, forcing the push rod of the scale against the vertical bar of the 1000 gram weight (f). As the frame of the scale continues to move and with the aid of the reaction of the coil spring of the scale, an increasing horizontal force will be applied

to the weight. When a sufficient amount of force has been applied, the 1000 gram weight (f) will be forced into motion. Due to the high friction of the rubber base of the 1000 gram weight, the top card will move together with the weight.

3.5 As soon as the weight begins to move, the operator shall take note of where the indicator disc on the 1000 gram scale hesitates momentarily or stops. Record the force in grams necessary to move the top card with its load of 1000 grams over the second card.

3.6 Coefficient of friction is normally considered as the ratio of the horizontal force to the weight being moved. To find the coefficient of friction of tabulation cards, divide the scale readings in grams by the weight (1000 grams). It may be readily seen that, since the weight is 1000 grams, the scale reading becomes the actual coefficient by merely moving the decimal place three digits to the left. For example, a scale reading of 350 grams is converted to a coefficient of friction value of .35.

3.7 When the 1000 gram scale (g) moves to its lefthand limit of travel, the operating lever (d) must be returned to the extreme right and the scale will then return to its original starting position. To hasten the operation, the operating lever (d) may be returned to the extreme right position immediately after the scale reading has been obtained for static and kinetic values.

3.8 Remove the top card just tested and place it on the bottom of the deck.

3.9 Follow the same sequence of operations for each of the remaining cards in the group until a total of ten readings are obtained.

3.10 The original procedure observed the maximum scale reading which occurred just prior to the lateral movement of the card being tested. We now designate this as the static friction of the card and it should be within the range of .30 to .45.

NOTE: Occasionally, the scale reading will change as the card continues to move laterally. This change may be slow or it may be rapid as has been experienced when waxes were added to the stock. The scale reading which identifies the friction when the card is in lateral movement will be designated as kinetic friction. The kinetic value can be either higher or lower than the static value. This is

determined by observing the location of the indicator disc after the static value has been determined.

## 4.0 REPORTING

4.1 Record the average of ten individual determinations for static and kinetic values and report.

## 5.0 NOTES

NOTE: Expereince has shown that there are several potential sources of error in results obtained on the IBM friction tester. To facilitate the elimination of errors, these are listed below:

5.1 BENT ROD on push-pull gauge which may result in binding at bearings. Rod may extend beyond weight stop. If this happens, rod may be cut to fall just behind weight stop.

5.2 DIRT on rod or in bearings of push-pull gauge and on rod which carries the indicator disk. These rods should be wiped occasionally with a soft cloth slightly moistened with a light lubricating oil.

5.3 Calibration pulley must be clean and free rolling. This can be achieved by soaking pulley in solvent (i.e. solox-alcohol) before calibrating tester.

5.4 The indicator disk of the gauges contains a small spring which presses against the rod. Since the scale is used only in a horizontal position, it is recommended that this spring be removed.

5.5 Burrs along the slot of the gauge case may interfere with movement of the pointer. If burrs are present, they should be removed with fine emery cloth.

5.6 If the notch provided in the 1000 gram weight stop becomes burred, there may be binding of the vertical bar of the weight. If this occurs, remove burr with fine emery cloth.

5.7 In the case of high card friction, the push-pull gauge may travel so far to the left before there is movement in the top card that the end of the gauge case strikes the top card causing it to move. If this happens, the top card should not be advanced quite as far to the right of the remaining cards.

5.8 If the rubber, with which the bottom of the weight is covered, becomes glazed or dirty, it may slide on the top card instead of carrying the top card with it. The rubber should be cleaned occasionally with alcohol or a damp cloth. If the rubber becomes rough or irregular, it should be ground smooth.

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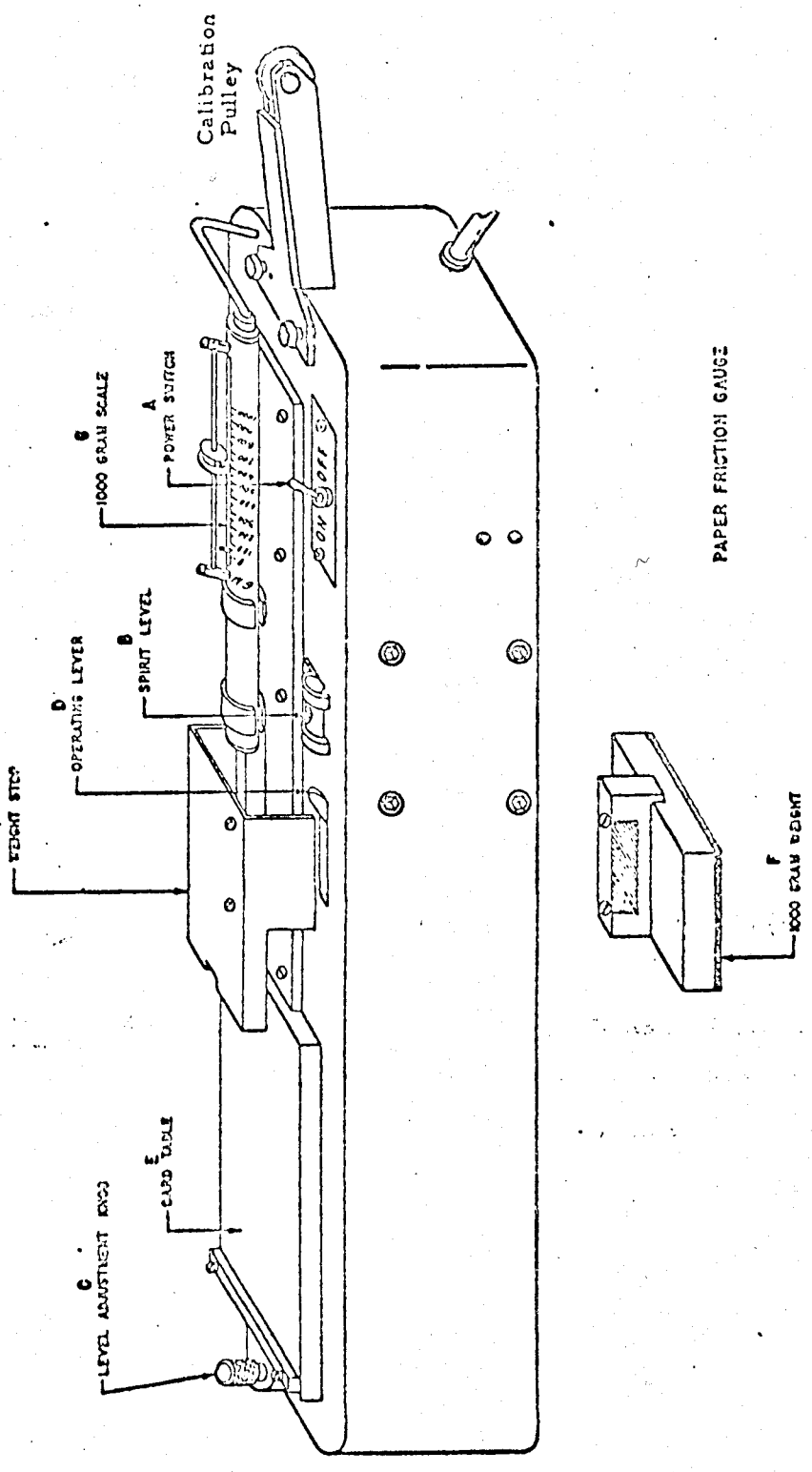


Figure 1