The Effect of Temperature and Relative Humidity Towards Collection Preservation Index (PI)at Main Library of Brawijaya University

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Abstract: One type of collection that can be used is a print collection made of paper. The collection damage is caused by temperature and humidity. These factors can accelerate chemical reactions and reduce the useful life of the collection.The benefit term is the time period or how long the material can survive in a storage environment condition. The benefit term is known based on the results of the preservation index (PI) value of temperature and humidity measurement data. This research was conducted at Library of University of Brawijaya precisely in three collection storage rooms. They were white, red and thesis label collections.The research was conducted for three months. The average temperature and humidity of the white label collection room is 26.4℃ and 75%, the estimated PI value is around 9 years.In red label collection room, the average temperature is 27.5℃ and 68% the PI value is around 10 years and in thesis room collection has average temperature of 25.2℃ and 52% then the PI value is around 24 years.

Keywords: Library Collection, Temperature, Humidity, Preservation Index (PI)

1. Introduction

One of library information source is printed collection that made from paper and should be in a good condition and ready to use. Printed collection or paper collection is the largest collection in libraries. A library collection will gradually damage especially printed collection that made from paper. Three main factors that caused physical damage to library collection are material characteristics (paper quality, acid that derived from cover), environment or physical factors (light, fungus, temperature and humidity) and human factors (insufficient binding or handling techniques)(Alahudin, 2014).

The condition of paper is affected by both internal and external factors. Paper suffer from deterioration due to endegenous (pH, metal ions, lignin, degradation product) and exogenous (heat, humidity, pollutant gases) contributors. Degradation of cellulose macromolecules can be brought about with various energy input i.e chemical, thermal, mechanical, or radiation energy and it can proceed via many reaction routes(Branin, Groen, & Thorin, 2000). The deterioration reaction that gives effect for aging paper is acid hydrolysis of glycosidic bonds between the glucose moieties of the cellulose macromolecule as shown in figure 1(Area & Cheradame, 2011). The main factor that must be controlled in a library is relative humidity of theair. The ability of the air to hold moisture is directly proportional to its temperature. As the temperature rises, the air is able to hold more moisture, and when the temperature falls, mist or fog can form in the air and dew droplets can condense on the surface of materials, providing conditions for fungal growth(Zhang, Zhang, & Shang, 2015).
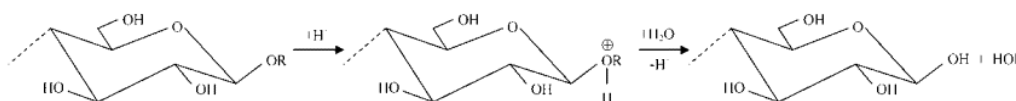

Figure 1: Acid-catalyzed Hydrolysis of Cellulose

Temperature and humidity are physical factors that can used to predict the lifetime of library collection. The standard of temperature and relative humidity for library are 20-25 ℃ and 45-55% RH(Perpustakaan Nasional Republik Indonesia, 2011). While the temperature and humidity fluctuated, the paper collection can easily spoiled because the paper will loosen and tense up(Fatmawati, 2017). If the condition happen continuously it can break the chemical bonding of cellulose and make the paper lifetime shorten.

The lifetime of library collection is the period of time which the collection can be store in storage environment until the collection is damage. The lifetime of library collection can be determined based on the result of preservation index (PI) value from temperature and humidity measurement in the storage room. Preservation index (PI) show the quality of storage environment condition for library collection. PI has a unit of

years and provide an overview of how long it will take for fragile organic materials such as paper to survive(Nadal, 2016). To determine the PI value at a certain combination of temperature and humidity can be seen in Table 1.

The main library of Brawijaya University has 60.873 book titles, 213.346 copies and approximately 426 damage collection from 1970-1990. The damaged collection such as loose several volume, yellow pattern in paper collection, moldy, dusty, and faded paper. Due to that condition Brawijaya University Library used as research place to find out the cause of physical factors for the lifetime of library collection.

Table 1: Definition of PI Value (Show The Estimation of Library Collection Lifetime in Years)
(Reilly, Nishimura, & Zinn, 1995)

Temperature (°F/°C)

Humidity (%)	32/ 0	37/ 2.7	42/ 5.5	47/ 8.3	52/ 11.1	57/ 13.9	62/ 16.7	67/ 19.4	72/ 22.2	77/ 25	82/ 27.8	87/ 30.5	92/ 33.3
5	2643	1731	1147	767	516	350	240	165	114	80	26	40	28
10	2234	1473	979	656	443	302	207	143	99	70	49	35	25
15	1897	1255	837	562	381	260	179	124	86	61	43	30	22
20	1614	1070	716	482	328	224	155	107	75	53	37	27	19
25	1373	914	613	414	282	194	134	93	65	46	33	23	17
30	1170	781	525	356	243	168	116	81	57	40	29	21	15
35	998	668	451	307	210	145	101	71	50	35	25	18	13
40	852	572	387	264	182	126	88	62	43	31	22	16	12
45	729	491	333	228	157	109	76	54	38	27	19	14	10
50	624	421	287	197	136	95	66	47	33	24	17	12	9
55	535	362	247	170	118	82	58	41	29	21	15	11	8
60	459	312	213	147	102	72	51	36	26	18	13	10	7
65	394	269	184	128	89	62	44	31	22	16	12	9	6
70	339	232	160	111	77	54	39	28	20	14	10	8	6
75	292	200	138	96	67	48	34	24	17	13	9	7	5
80	251	173	120	84	59	42	30	21	15	11	8	6	4
85	217	150	104	73	51	36	26	19	14	10	7	5	4
90	187	130	90	63	45	32	23	16	12	9	6	5	3
95	162	112	79	55	39	28	20	15	11	8	6	4	3

2. Objectives of Study

The objective of this study is to monitor the condition of collection storage room in the main library of Brawijaya University especially for the daily average temperature and humidity in order to determine the PI value as an estimation of collection's lifetime.

3. Literature Review

3.1 Preservation

Preservation is the elements of management, finance, storage, tools, labor, and methods used to preserve library materials, documentation, archives, and the information (Lasa, 2009). The purpose and objective of preservation according to Martoatmodjo (2010)is to ensure that library materials are not damaged quickly. Library materials are expensive, made to be durable, can be used longer and can reach more library readers. Collections that are treated are intended to be attractive, so that people who are reluctant to read or use library books become diligent in using library services.

The librarians really need to know the factors that affect damage to library collections. The factors of damage to library materials are caused by:

1. Internal factors

   Internal factors is a factor that caused by paper materials, printing inks, adhesives and others. Paper is composed of chemical compounds which will gradually decompose due to high and low temperatures and the strength and weakness of the light hitting the collection. Collection covers made of cardboard usually contain acid, the acid process will transfer to the paper in the book which causes a decrease in the quality of the paper. In this condition, the paper becomes brittle and crumbles quickly.

2. External Factors

   Factors that come from around the collection which are placed, for example: environment related to physical factors, humans, natural disasters, and biota.

3.2 Temperature and Humidity

Climatic factors such as temperature and humidity are the causes of damage to library materials. The level of temperature and relative humidity during long-term storage of library materials is known to have a significant impact on conservation. Therefore, both variables must be at a level that must be maintained in the storage room and reading room. The lower the storage temperature and humidity, the longer the paper material can maintain its physical strength(Dureau & Clements, 1990).

The humidity that is too high or too low will cause problems. The combination of high temperature and high humidity accelerates the growth of mold and insects. When the humidity is too high it will cause the water-soluble ink to spread and the paper in the book will stick together, which will be difficult to remove when dry. Conversely, if the humidity is too low, it will cause the paper to dry out and the covers made of leather will become wrinkled(Alahudin, 2014).

High temperature can cause the paper to become brittle, the paper will turn yellow. If the humidity is also high, it can cause the book to be attacked by fungi, termites, cockroaches, bookworms and silver fish so that the books become brittle and tear easily (Martoatmodjo, 2010).

According to Technical Guidelines for Library and Information Services(Makarim & Ramdhan, 2014),buildings and spaces that are representative and in accordance with the vision, mission, goals and various functions of library and information services in the National Library by paying attention to the regulation of light, air, sound, spatial planning , humidity levels in the building and library room as well as library service systems that will be implemented. There are three main rooms that must be planned, namely for library collections, library staff and other rooms needed to support the library, such as exhibition rooms, theaters, and seminar rooms. While the room conditions for the book collection room, reading room, and work space that are desired are to have a temperature of 22 - 24°C and for a computer room it is 20°C with a humidity of 45 - 55%.

3.3 Preservation Index (PI)

The useful life of the collection or the Value Preservation Index (PI) is a representative of the estimated time that unstable organic materials such as books, magnetic tape binders or color slides will survive the combination of temperature and humidity(Reilly et al., 1995). Can also be said as the length of time or how long the material lasts in terms of the time it takes to deteriorate even though it can still be used in a damaged state. The useful life of the collection can be determined based on the results of the PI value from the temperature and humidity measurement data. PI is a way of showing the quality of preservation in measuring and talking about the environmental effects of temperature and humidity that affect the decay rate of chemicals in problematic materials such as acid paper, color photos, and binding adhesives(Nadal, 2016).

The PI helps to measure how good or bad conditions the storage environment is in deteriorating chemical collections. PI values are in units of years and provide an overview of how long it will take for a fragile organic material such as paper to last. The "year of life" aspect of PI values is not intended to be a predictor of the useful life of a particular object. It is simply an accurate measure of the life expectancy of the entire collection of the effects of environmental conditions when measuring temperature and humidity(Reilly et al., 1995).

To determine the PI value at a certain combination of temperature and humidity, see the PI definition in table 1. The PI definition table has temperature at the top, relative humidity on the left side and in the main table is the PI value.PI value tables are useful for illustrating the extraordinary impact of cold, warm and dry, humid conditions on the life expectancy of inherently unstable library materials. In very cold and dry conditions the PI value is high and in warm and humid conditions the PI value is low. so that it can be described in the storage room conditions of 57°F (13.9⁰C) and 50% has a PI value of 95 years, meaning that the collection in that room can be estimated to be degraded in about 95 years if stored continuously at 57 ° F (13,9⁰C) and 50% of the time. Table 1 will also show that a number of different combinations of temperature and humidity will produce the same PI value. Chemical decay is the worst threat to library collections and archives. Therefore, PI is a good indication of the overall "quality of preservation" of the storage environment(Reilly et al., 1995).

4. Reserach Methodology

This study is using observation method. The data collection was carried out by direct measurement using thermo-hygrometer (figure 2) at library rooms collection (three room collection there are while labels, red labels and thesis collection). These study was conducted for three months and data was collected from 8am to 5 pm with 1 minute intervals.

Figure 2: Thermohygrometer

5. Discussion and Conclusion

Discussion

The research that conducted at the UB Library produces different temperature and humidity data in each collection room due to different storage environment conditions. The white label collection room does not have air conditioning while the red label collection room has 15 fans but not all of them function and the thesis collection room have air conditioner (AC). Temperature and humidity data are presented in Figure 3 and Figure 4.According to the (Perpustakaan Nasional Republik Indonesia, 2011)standard, the temperature and humidity at storage rooms are 20-25 ℃ and 45-55%. Based on Figure 1, in the white and red label collection room the average temperature does not meet the standard with a temperature of 26.5 ℃ and 27.5 ℃, while in the thesis collection room the temperature is close to the standard with a temperature of 25.2 ℃. Based on Figure 2, the humidity in the white and red label collection room also did not meet the standard with an average humidity of 75% and 68%, while in the thesis collection room the humidity met the standard with a humidity of 52%.
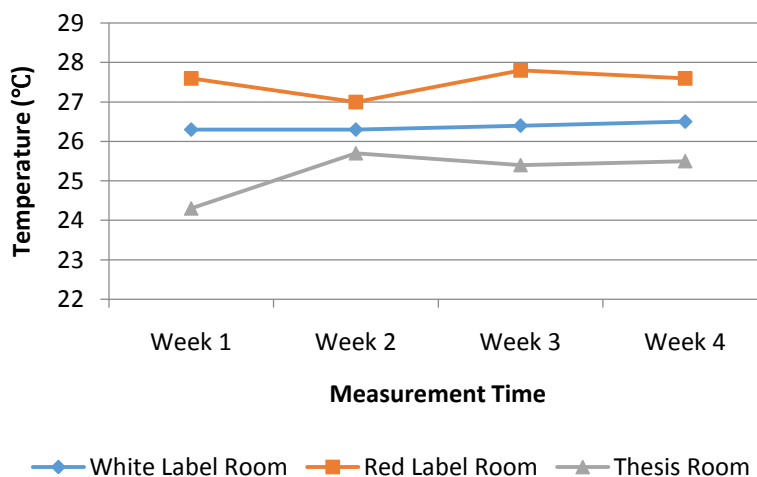

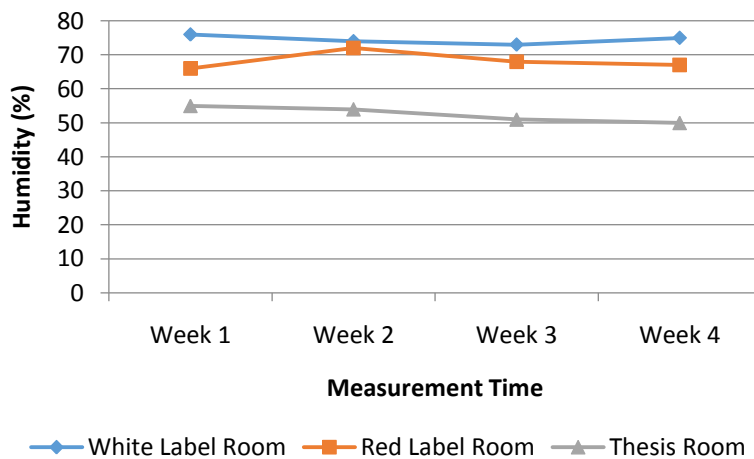
Figure 3: Average Temperature Measurement

Figure 4: Average Humidity Measurement

The results of the average temperature and humidity in each room of the Brawijaya University Library can be matched in Table 1 to determine the lifetime of the collection. In the white label collection room with a temperature of 26.4 ℃ and a humidity of 75%, the estimated PI value is around 9 years, in the red label collection room with a temperature of 27.5 ℃ and humidity of 68%, the PI value is around 10 years and in the collection room thesis with a temperature of 25.2 ℃ and a humidity of 52 ℃ then the PI value is about 24 years. The PI value in the thesis room is higher than the white and red label room due to the influence of temperature and humidity in the thesis room which is lower than the white and red label collection room so that the estimated time is longer. A high PI value will describe a longer lifetime estimation than a low PI value. The lower the influence of temperature and humidity in the room, the higher the value of PI or longer lifetime estimation.

As a result of collections that are kept constantly on the room temperature and humidity that are not meet with standards, the collection will be damaged such as cover cracked, yellow pattern, moldy and color faded. High temperature and low humidity will cause the collection to be dehydrated so that the collection becomes dry or wrinkled, the book cover is cracked as shown in Figure 5a. In Figure 5b the yellow pattern collections are also caused by high temperature or low heat and humidity. In Figure 5c, the moldy collection is caused by low temperature and high humidity. In Figure 5d the colors on the paper are fading, this can be due to the age factor and because the ceiling is leaking, causing a lot of moisture. The moisture will make the paper wet and cause the color to run out the paper.
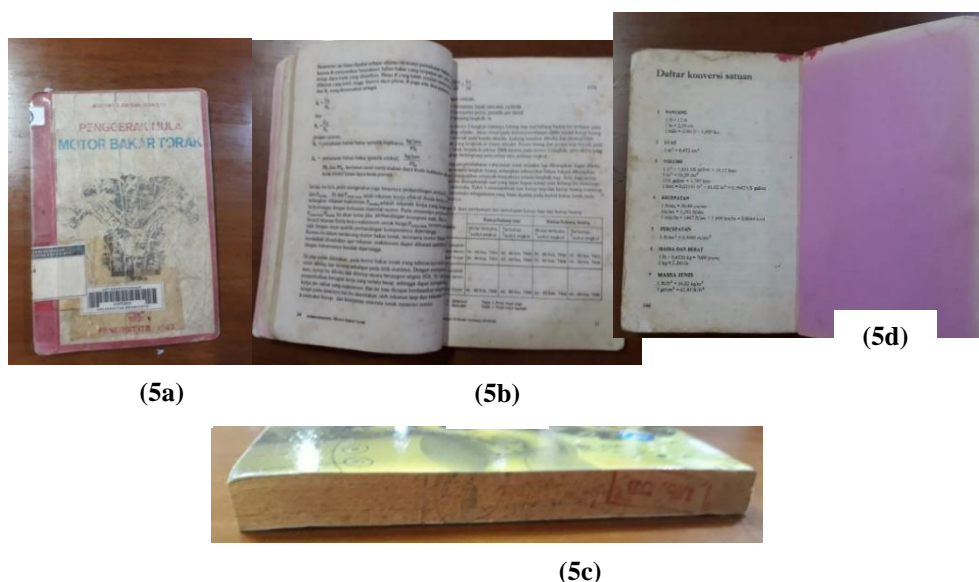

(5a)   **(5b)**   **(5d)**

(5c)

Figure 5: (5a)Wrinkle Collection, (5b) YellowingCollection, (5c)Fungus inCollection, (5d)Faded Collection

Conclusion

The temperature and humidity in each room that approached and met the standards were only in the thesis collection room with a PI value of about 24 years. The PI value in the thesis room is higher than the white and red label collection room because the influence of temperature and humidity in the room is low, besides that there is one aspect (humidity) that meets the standard. In the white and red label collection room, an air conditioner should be added so that the temperature and humidity can match the standard and the lifetime of the collection is longer.

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