Trends In Paper Drying Section For Higher Productivity

Raghuveer S.

ABSTRACT

Changing furnish, coupled with high-energy costs, have marginalised several paper machines and let to shut downs of non-competitive mills. According to the market assessment, about 50% of the paper and paperboard machines installed are having drying limitations. This prevents many paper producers from increasing production on existing machines. The reality is that, the drying section of paper and paperboard machines take up 2 / 3 of the length of the total machine and requires 60 –70% of the total power required by the paper machine. Improvement in dryer section ensures considerable saving in energy and also increases the productivity. Such improvements in dryer section can be of, replacement of the dryer felts by better synthetic screens, increased ventilation with proper hood, adoption of improved cleaning methods of the dryer screens and also increasing the drying capacity by installing radiation based drying systems etc. All these cumulatively, will lead to higher productivity of the machine and better profitability with lower investments. Those mills, which have opted these methods, have achieved significant increase in machine speeds, operating efficiencies and reduced specific energy costs.

Introduction

Drying is the last major process in paper and paperboard manufacturing.

The sheet, which is formed in the forming section, it is consolidated and dewatered to a certain extent in the press section, enters the dryer section for the removal of remaining extra water in the structure, where it is dried to its finished condition of 5% water or to the level of existing humidity in the ambient air. This drying is accomplished through the supply of heat to the sheet by large steam-heated cylinders. The wet fiber sheet is conveyed to the dryers through dryer felts.The primary function of a dryer fabric is to keep the sheet in contact with the dryer cylinders to provide maximum heat transfer from the cylinder to the sheet. If a wet object is placed against a heat source, the water on the surface will heat up. In the case of paper, the evaporation of the heated water creates a positive pressure that tends to lift the sheet off the dryer. This reduction or loss of contact with the dryer will result in poor heat transfer and poor drying efficiency. The other associated problems in the paper dryer section are inadequate ventilation due to clogging of the wires with contaminants and poor ventilation conditions. With better ventilation, it is possible to improve evaporation and even the pocket / sheet moisture profile. It also affects steam consumption of the cylinder and therefore saves energy costs. The need to meet the increasing production volume as well as paper quality requirements puts significant pressure on fine tuning of the old paper machinery. There are numerous 15-30 years old paper machines that still have years of mechanical life time ahead but which should be modified to meet the increasing speed and efficiency requirements. This is, however, quite complicated because of several production bottlenecks that limit the paper machinery speed up.

Over the years , the paper machines are being developed of higher speeds. Fig-1. Shows the increase in machine speed over the years (1). Normally, the drying section consists of 40 to 50 steam heated cylinders. Steam of 6 to 12 bar is brought into the cylinders where it condenses. Water in the sheet is removed by evaporation. The heating pattern at the dryer section is shown in Fig-2. The temperature at the cylinder

PAPER MACHINE SPEEDS

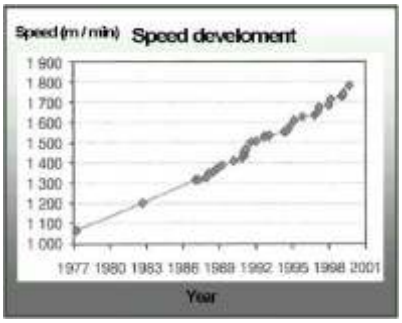

FIG. -- I

HEATING PATTERN IN PAPER DRYER SECTION

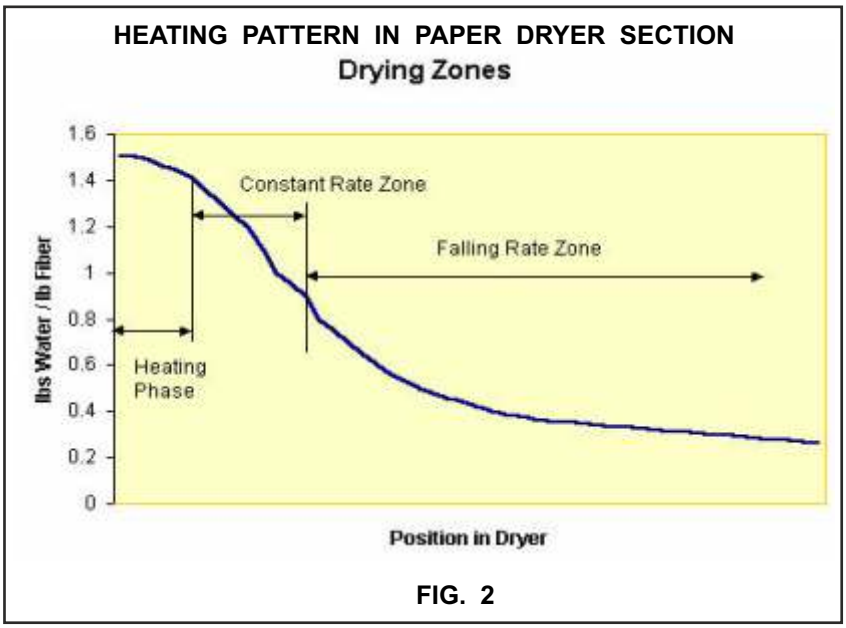

FIG. 2

ITC Ltd.-PSPD
Unit: Bhadracalam, Vill.. Sarapaka
Dist. Khammam-507128(A.P.)

surface varies from 100°C to 165°C. Table-1.shows the composition of the stock and the amount of water removed at various sections of paper making. Added to this, to stay in the today's business, one has to increase the use of recovered fiber, need to increase the speed of the machine for higher production. Unless the drying capacity is increased, all these are not feasible. With the adoption of the following simple improvements in the machine drying section, one can reap the benefit of increased production.

TABLE – 1

DE WATERING / DRYING OF PAPER AT VAROUS SECTIONS

Stage	Fibres (kg)	Water (kg)	Dry matter content (%)	Water removed	
				(kg)	(%)
Ingoing	950	94050	1		
After forming	950	3800	20	90250	96
After pressing	950	1425	40	2375	2.5
After drying	950	50	95	1375	1.5
				94000	100

They are:

I. **Replacement of dryer fabrics with improved and high permeable synthetic Fabrics.**
II. **Improving the drying rate by installing closed hood.**
III. **Improved method of felt cleaning.**
IV. **Supplementing with *INFRA RED* drying system for increased drying capacity.**

Suggested Actions To Increase The Dryer Section Productivity

Under Standing The Need Of Paper Machine Clothing

The entire process of converting pulp into paper would not be possible without paper machine clothing. Forming, press and dryer fabrics fulfill the essential function of carrying and supporting the paper sheet when it is formed, pressed and dried.

Since no two paper machines are alike in design and size, and due to a great varieties of paper grades are produced, the choice of paper machine clothing is an important task.

The dryer fabric helps to support the its paper web as it moves from one cylinder to another and between the dryer groups. Dryer fabrics also transmit drive to un-driven cylinders and lead rolls. Another requirement of the dryer fabric is to help in heat transfer and / or improve the sheet contact with the dryer. This is the primary function of a dryer fabric. There is also a layer of air between the sheet and the dryer that is carried by the moving sheet and dryer. Most of the modern dryer fabrics are woven textile made of synthetic yarn. These fabrics are permeable in that air can pass through the fabric structure. This chacteristict is called permeability. The permeability is expressed as the amount of air(cubic feet per minute) that will pass through a square foot of fabric per minute at a pressure drop of 0.5 inches of water. The common value is stated as **c f m.** The range of permeability of today's dryer fabrics is low of 50 cfm up to 1000 cfm.

Table-2.shows the different permeability value with various dryer fabrics (2). Fabric permeability determined by the structure of the fabric, the sizes and the type of the yarn used. The amount of air carried is directly proportional to the speed of the fabric.

TABLE -- 2

AIR PERMEABILITY OF VAROIUS DRYER FABRICS

TYPE OF CLOTHING	AIR PERMEABILITY (c f m /Sq.ft at 0.5 in H_2O)
2- Layer Cotton Dryer felt	2
2-Layer Synthetic- asbestos dryer felt	5
3-Layer Cotton dryer felt	4
4-Layer Cotton dryer felt	20
3-Layer Cotton warped, asbestos-wefted resin coated dryer felt	200
Medium permeability multifilament dryer fabric	400
High permeability multifilament dryer fabric	550
High permeability monofilament dryer fabric	700

Structures Of Dryer Fabric:

Polyester has good tensile strength and acid resistance. However, most of the times acrylic will be preferred due to some hydrolysis problem with polyester. Polyamides and acrylics are usually mixed in order to produce yarns with very high hydrolysis resistance. Polyphenylensulphide (PPS) has very good resistance against heat, chemicals and hydrolysis; however, It has mediocre tensile strength and abrasion resistance. Additives are used to improve some of these properties. PPS is relatively expensive. Polyetherether-therketone (PEEK) has excellent heat, hydrolysis and chemical resistance. However due to its high price, it is only used in special cases. Nowadays, polyproplylene (PP) is not used due to low permanent heat resistance. Teflon (PTFE) is also not used due to its low elongation strength. Dryer fabrics must be able to resist degradation from humidity, temperature, wear (abrasion) and chemical cleaning additives. Modifications to the fabric design and polymer used to make the yarns can assist with this. For example, changing the weave pattern so that temperature resistant yarns are only present on the paper side of the fabric will prevent temperature related degradation at the sheet edges, where the paper web is not available to protect the fabric from the hot dryer cylinder.Fig.3.shows the fiber weave pattern for heat protection.

PAPER SIDE OF DRYER FABRIC

FIG. -- 3.

Non Paper Side Of Dryer Fabric

Dryer fabrics are designed as per the specification of the machine, the position, type of paper to be produced etc., Depending on the manufacturing process, dryer fabrics can be divided into three main groups.

I). Woven fabrics
ii). Spiral fabrics
iii). Needle fabrics (batt on base)

Reduction In Energy Consuption By Use Of Modern Fabrics.

Modern dryer fabric designs provide energy benefits by improving sheet-to-dryer contact, improving air movement in dryer pockets, and providing resistance to fabric filling. Installation of modern fabric designs has produced higher overall paper machine efficiency on several machines. A fabric's permeability determines how quickly evaporated moisture can be removed from the pockets of the dryer section. Dryer fabrics can be woven to give very different permeabilities, depending on the machine requirements With a carefully chosen clothing, paper machine runability can be substantially improved. Moreover, this also results in enhanced paper quality and energy savings.

VENTILATION

Improving The Drying Capacity By Installing Closed Hood

For every ton of paper dried on paper machine, approximately two tons of water is evaporated into the atmosphere and it is estimated, 50 to 60 tons. of air is required to remove the water vapour. The conditions and direction of flow of this air has important bearing on the drying efficiency of the machine. Old machines are often covered only by roof of the machine house, with few vents to allow moisture laden air to escape. A false roof is some times built over the machine. It is important that the machine house be supplied with air at proximately the same rate as it is being

Evaporation rate on dryer surface

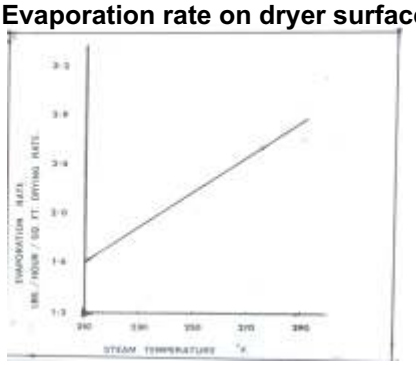

FIG. -- 4

Dryer surface evaporation vs machine speed

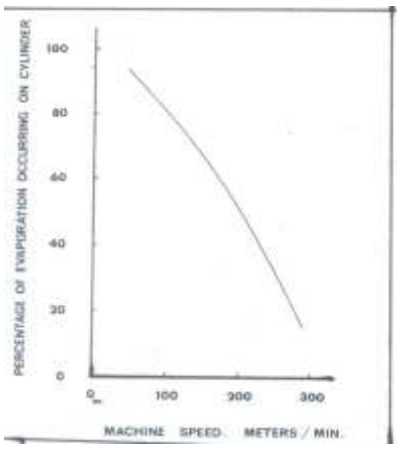

FIG. -- 5

extracted. Fig - 4. shows the evaporation rate on dryer surface & Fig-5. shows its link with machine speed.(3).

Totally Closed Hood

In the Closed hood system, covers extend to the machine room floor and down into the basement. The side panels are generally in three sections. The top sections on front and back are fixed. The lower front sections can be lifted vertically to provide a clean working space for handling the broke. Fig-6.shows the cross section of a typical closed hood.(4).A well designed hood system will reduce the heating requirements at the drying section as much as 35%. An automatic hood control system can be installed at the suction of the exhaust fan to have better results. Modern totally closed hoods can operate with dew point as high as 65ºC. This would mean that the exhaust air and supply air volumes can be brought down quite substantially, thereby saving on drive power for the fans. Further, since the same amount of heat is available in a smaller quantity of air, this exhaust air is better utilised for heat recovery because of higher differential pressure at the heat recovery units.A well designed closed hood system and automatic hood control at the suction of the exhaust fan is recommended. The following are some of the advantages that can be obtained following the installation of a totally closed hood along with energy savings and quality improvement.

CROSS SECTION OF A TYPICAL TOTALLY CLOSED DRYER HOOD

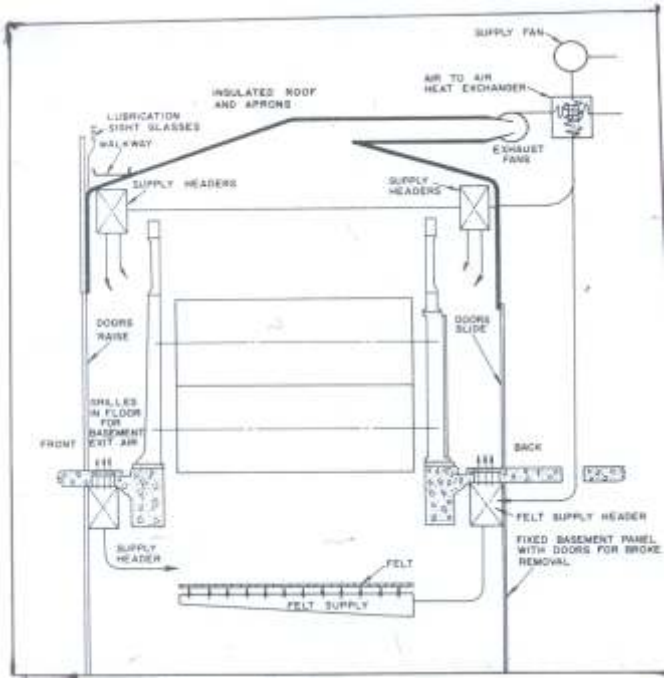

FIG. -- 6

I). Reduced steam consumption: It is reported that the average steam consumption is about 0.2 tons. Steam per ton. of water evaporated.

ii). Reduced volume of supply and exhaust air.

iii). Improved cross machine sheet moisture distribution at reel.

iv). Improved machine efficiency.

v). Improved working conditions.

Better Method Of Felt Cleaning.

Need For Felt Cleaning

High-speed machines are particularly sensitive to loss of dryer fabric permeability and the resulting effects on sheet handling. Buildups on dryer fabrics can also become dislodged during paper manufacturing, resulting in defects and breaks. Additionally, many new generation hi-tech dryer fabrics employ engineered surfaces differing between machine and paper side for peak performance. Contamination can negate many of these important properties, making the dryer fabric little more than a transporter of the sheet In the worst case, this can lead to sheet defects, poor moisture profile, and ultimately end-user dissatisfaction. Today, cost and quality pressures are at an all time high. Dryer fabric performance contributes greatly to the paper machine running efficiently, producing high quality paper, and operating at the lowest possible cost. The best practices of fabric design, showering, and chemicals all play a part in making a significant contribution to a publication machine's performance. No dryer fabric alone can run contaminant free. All fabric structures require cleaning mechanisms to remove and dislodge contaminants. To facilitate the effectiveness of the process, dryer fabrics can be produced of yarn material with flouropolymer additives included. The flouropolymers change the surface characteristics of the fabric to make cleaning easier and more effective.Over the last few years, additional focus has been placed on developing structures that are less likely to trap and hold contaminants. This type of structure allows improved mechanical shower penetration, resulting in better removal of contaminants than is achievable with a round CD yarn structure. As performance demands increase, so will the need to give special attention to maintaining the dryer fabrics' effective drying capabilities. Paper machines that use recycled fiber are more susceptible to these issues, but this situation can also occur in virgin furnishes from pitch, starch and coating materials such as latex.For removal of paper machine contaminants when the deposit load exceeds the system's capacity to purge on its own, the application of mechanical action (e.g. high-pressure showering), high temperature water and the correct chemical cleaning agent will yield the optimum result, especially when these factors are combined. Thus, fabric properties and performance can be maintained over the clothing lifetime. This integrated approach effectively prevents and removes contaminants from the fabrics and paper machine surfaces in a safe and effective manner during production. Table.3.shows the melting point of various contaminants.(5).

Continuous Cleaning Of Machine Fabrics With Showers:

High pressure air showers have shown promise where the primary contaminants are dust and filler particles. The most ideal means of removing organic contaminants common to coated and recycle containing grades is by continuous showering using hot low volume water under high pressure. There are several systems commercially available that employ cleaning heads utilizing small diameter nozzles that clean from the paper side.Fig-7. shows this system. As demand for cleaning increases, so do the efforts to improve the cleaning equipment. As effective continuous cleaning strategies that do not affect the sheet emerge, dramatic improvements in dryer fabric cleanliness can be expected. Another major drawback experienced with equipment is mechanical reliability. The environment is extremely harsh, historically making efficient use of units costly and challenging.

Chemical / Batch Cleaning:

The use of chemical cleaning agents typically is done on down days or extended sheet break periods while the machine is on crawl speed. Automated systems are commercially available to aid in the efficiency of batch washing. At least one system employs steam to heat the cleaning solution and offers automated pre-soak, chemical wash, and rinse cycles. This strategy has been effectively used on extended breaks where additional wet end clean up, doctor changes, etc., are taking place. This allows dryer fabric cleaning to occur in the background with minimal operator intervention.(6).Traditionally, chemical cleaning agents have been applied to the fabric through shower piping, located in a top position between two cylinders before a roll or on the inside of the fabric just before or after the last cylinder. The first alternative can be used to saturate both top and bottom fabrics. In either case, the primary objective is to apply cleaning chemicals as soon as possible after the fabric separates from the last dryer cylinder.

TYPICAL FELT CLEANING SYSTEM

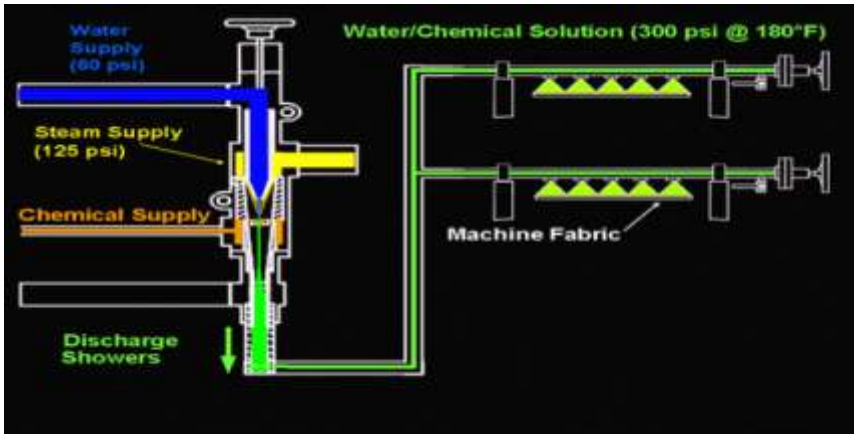

FIG. -- 7

Increasing The Paper Drying Capacity By Supplementing With Infra Red Heating

IR Paper Dryer

Traditionally paper is dried with steam filled drums as it is pulled through the line. Drying is an energy intensive operation, accounting for 35% of the steam energy requirements of an integrated paper mill. Drying speed/capacity is the limiting factor in many paper mill production capabilities. By adding Gas IR Dryers to a paper manufacturing line, production can be increased much more economically than other drying expansion options, such as lengthening the line or adding steam dryers.

Gas-fired infrared burners are widely used by the paper industry to dry coatings and to improve moisture profile across the web. The use of gas IR is less frequent for preheating and bulk water removal applications in the constant-rate and falling rate zones, since these applications are relatively new and scarce. Preheating and water removal applications offer a very profitable way to increase production from drying limited machines. Gas IR heaters produce an infrared wavelength that is readily absorbed by the water in the sheet. This leads to a higher temperature and a drying efficiency increase that cannot be duplicated by conduction and convection temperatures alone. Table-4. shows the energy distribution in IR drying.(7).

The use of IR burners for paper drying offers the following advantages:

- **increased drying capacity**
- **increased productivity**
- **reduced energy costs**
- **profiling capabilities**
- **improved quality**
- **reduced maintenance**

Types Of IR Dryers In Use In Paper INdustry

There are two kinds of IR Dryers used to dry paper:

1. conventional high-intensity IR heaters made of ceramic or metal heating units arranged in a rectangular grid and placed above (and/or below) the paper sheet
2. an INTERNALLY heated drum dryer that takes the place of a steam-filled drying drum

Conventional IR

Conventional infrared dryers can be placed along the line to compliment existing steam drum dryers. The IR energy penetrates the paper and dries from the inside out. There is no contact so on some types of paper, product quality is improved. When used with cross-directional moisture scanning (CD), the burners can be staged to get correct/ even drying across the web. Burners are made of ceramic or metal materials that heat up and cool down very quickly, allowing the tight CD control, and improving safety. They cool below ignition temperature as quick as 1 second after shutdown. They heat up to operating temperature in about 10 seconds.

The IR wave-length is more acceptable to paper than that of electric, so it is more efficient in addition to being a lower cost fuel. Gas burners are considered 30 -60% efficient when measuring the paper temperature before and after the burner. If used in conjunction with gas fired convection drying, efficiencies increase to 65 -80% by keeping the air above the surface of the paper moving. Production increases of 1-10% are possible. Fig-8.shows the preferred positioning of IR dryers.(8).

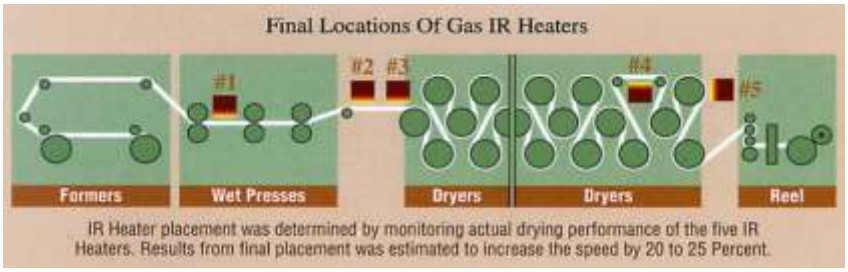

FIG. -- 8

IR Drum Heater

New developments are; in-drum radiant heater system that increases drying capacity by increasing the surface temperature of a drying drum/can over what is possible with a steam system. The gas fired drum is a direct replacement for an existing steam drum and provides drying via direct contact with the hot surface of the drum.

TABLE -- 3

MELTING POINT OF MAJOR FELT CONTAMINANTS

	C
LWM plastic	55
Adhesives	
Pitch	60
Un saturated AKD	
HMW Plastics	
Latex	70
Saturated AKD	
Hydro Carbon waste	80

TABLE - 4

DISTRIBUTION OF ENERGY IN IR HEATING

	%
Radiation Losses	10
Exhaust Gases	35
I R Heating of Paper	55
TOTAL ENERGY	**100**

Conclusion

In the present day's paper market, survival is for the fittest. Paper mills which cannot compete will be shut down. The Indian paper industry has number of inherent disadvantages, such as high energy intensive and low production capacities.

Thus , the industry has to improve upon its efficiencies in every aspect and become cost competitive. Further, companies would be required to focus more on improving the performance of their existing paper machines for higher productivity with quality and energy conservation.

Acknowledgement

The author acknowledges his sincere thanks to the management of ITC. Ltd., PSPD.,
Unit: Bhadrachalam, for permitting to present this paper at **IPPTA WORKSHOP** , OCT.2009., SAHARANPUR ,INDIA.

Reference

1. Esavirtanen, Riikka Gerlander and Ilop pitkaniemi, "Optimisation Of Pmwetend, Ventilation of Machine clothing.APPW Journal paper 2004.

2. Nissan,A.H. "Functions of the felt in water removed efficiency on the paper making Machines" TAPPI 37, No.12 597(Dec.2009).

3. Janson, L. and Nordgren, B. "The drying of paper on felt covered cylinders" Svensk paperstiding.61.No.19,834(OCT.2008).

4. Race, E. , Ashwarth. T.N. , Danglas , J. W. and Garment H. " Hot air Blowing Rolls with condensation Dryer felt and Open mesh Dryer fabrics" Tappi, 49,No.9.624 (SEPT.1966).

5. Information on Mechanical cleaning Solutions by Heliojet Cleaning Technology, Incorp.Newyork-2009.

6. Kenneth,w. Britt "Hand Book of Pulp and Paper Technology" Second Edition.1984.Page.427.
7. & 8.Literatures of The Energy Solutions Centre " Gas IR Drying Consortium, N.Y.(2007).