Configuring a Paper Rewinder for Energy Savings

Author: Sourabh Mittal
First Edition, Jul 2021

Contents

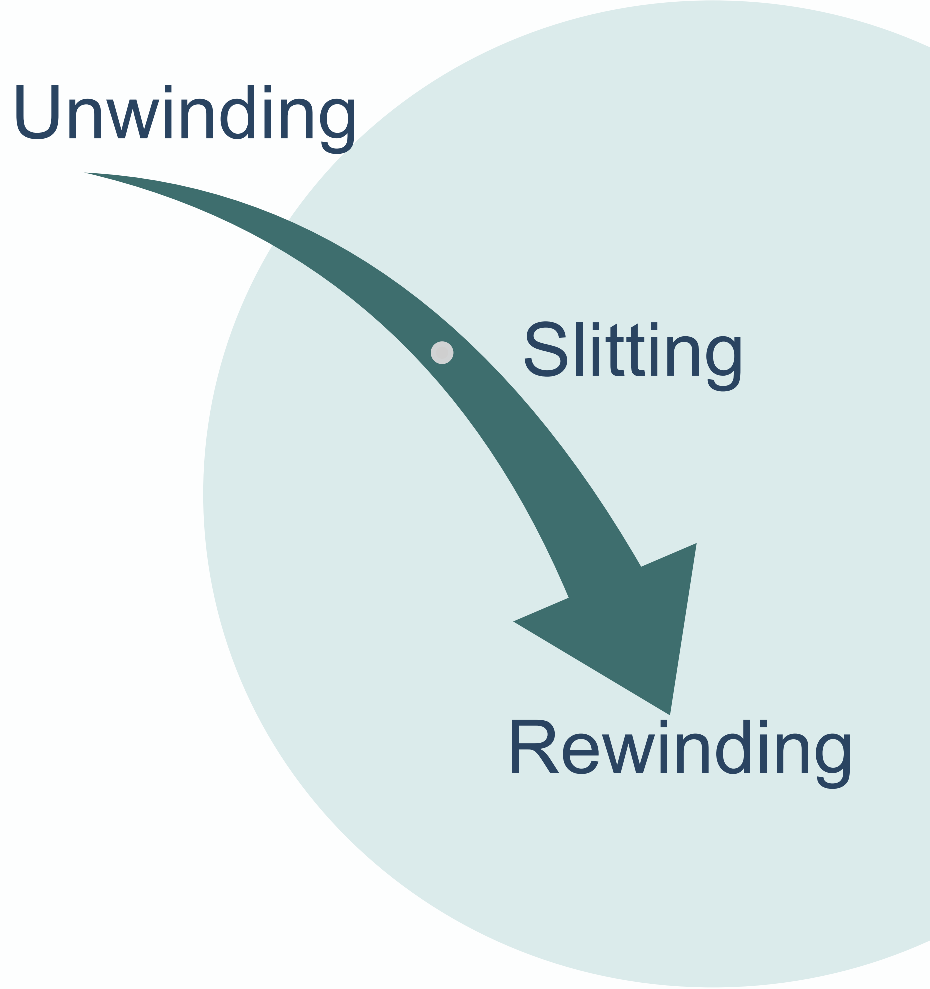
Saving energy on a fully automated paper rewinder process?

A **“Paper Rewinder”** is the heart of a paper plant. After journeying through several processes, the paper is reeled on pope reel and is sent to the rewinder section of the paper making process. At the rewinding station the paper is unwound and cut into smaller deckle rolls as per a customer’s requirement.

...but **how is energy saved on the rewinding process?** Well.. read along.

A rewinder consists of three parts - unwinding station, slitting station and rewinding station. For wrinkle-less rewinding and to maintain the right amount of tension during the process, brakes are applied on the unwinder.

A lot of energy is dissipated in the form of heat by external resistance at the unwinding station and can be harnessed and fed into another process such as rewinding, down the line, using a sophisticated motor control system. This results in power savings.



Braking Methodologies used in the Unwinding Process

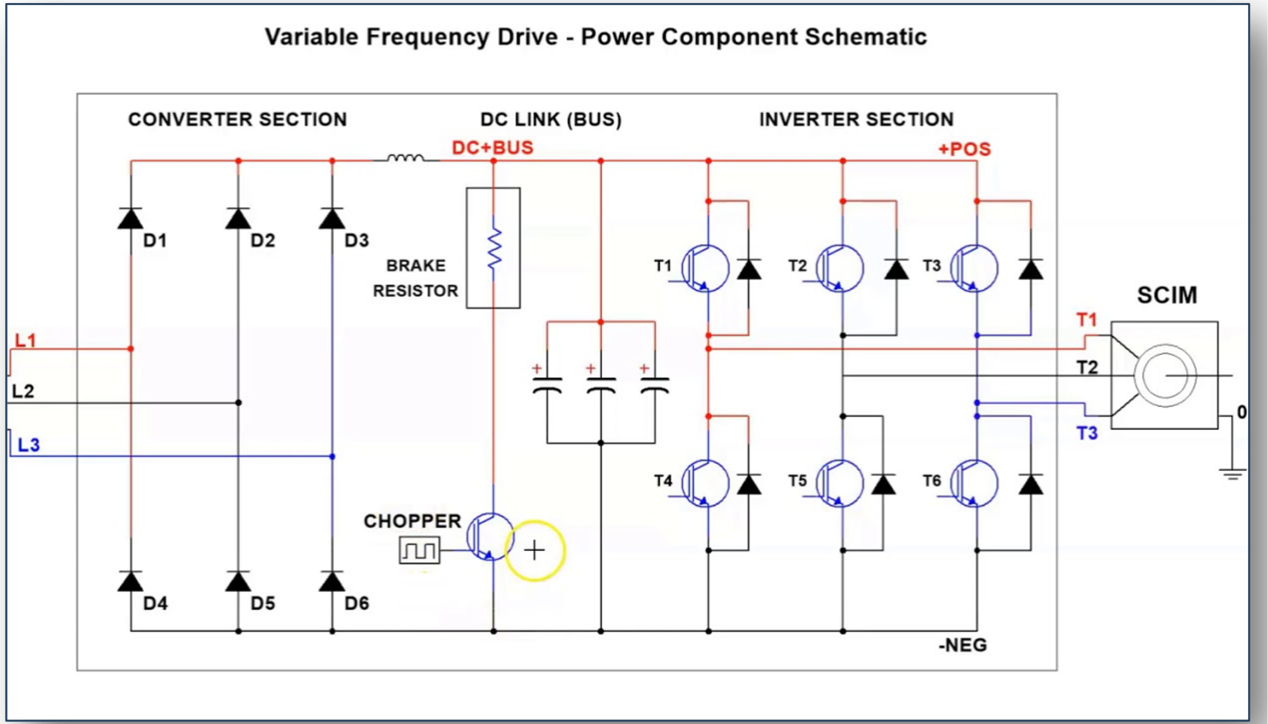
The most conventional method of braking at the unwind station is using a pneumatic cylinder where circular brake liners are used to brake and maintain tension. However, in this method, there is greater wear and tear, and higher cost of maintenance as the brake liners wear out fast. Additionally, tuning can be a challenge to get good reels of paper.

In contrast, in order to perform the basic operation of a brake we can simply apply reverse force using an electric motor. The motors are excited to act as a generator where the rotor speed > emf speed. The EMF is reversed to produce a braking torque while the rotor continues to rotate in the its previous direction due to inertia. As the excitation current is increased, more braking torque is generated to prevent the rotor from rotating in its direction of inertia resulting in a braking action.

Voila! Here is where you can save some energy!
Siemens Sinamics AC drives are designed to utilize the energy generated by the motor in the downstream rewinding station. Before we get into the specifics, Let’s quickly visit the functioning of a drive system.

Variable Frequency Drives

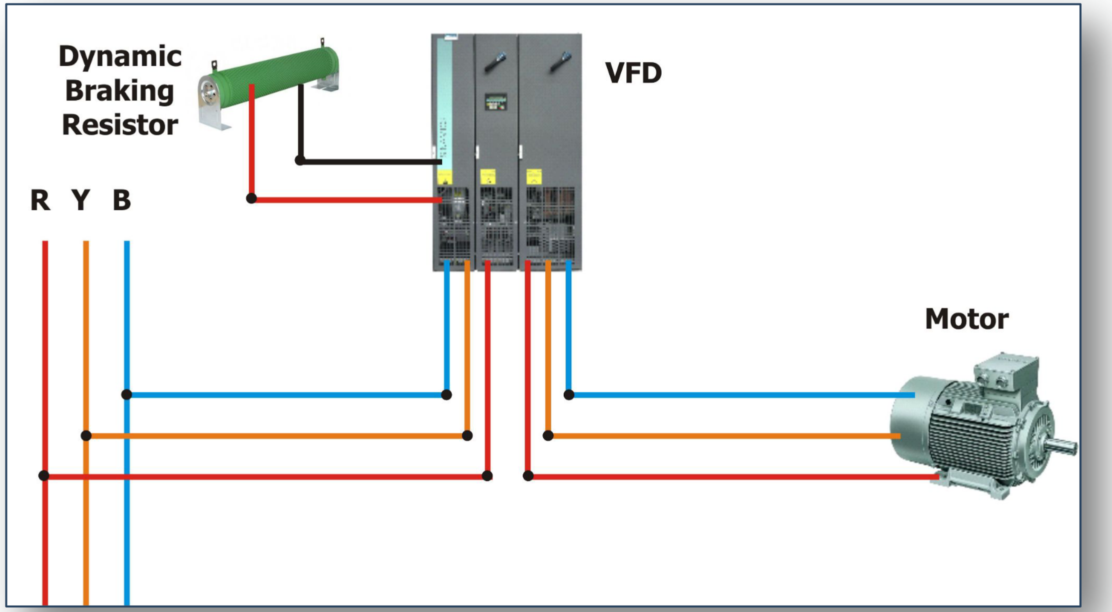
An AC Drive consists of three major sections: A rectifier, a DC Bus and an inverter. The AC input applied on the VFD is converted to DC by a full wave rectifier circuit. This rectified DC output is filtered using capacitors to reduce harmonics. This is typically done at higher voltage of approx. 500- 800V to reduce current load on system. The DC output is converted to AC by using IGBT based inverter circuit. By varying the voltage and frequency of this AC supply the speed and torque of motor is controlled.



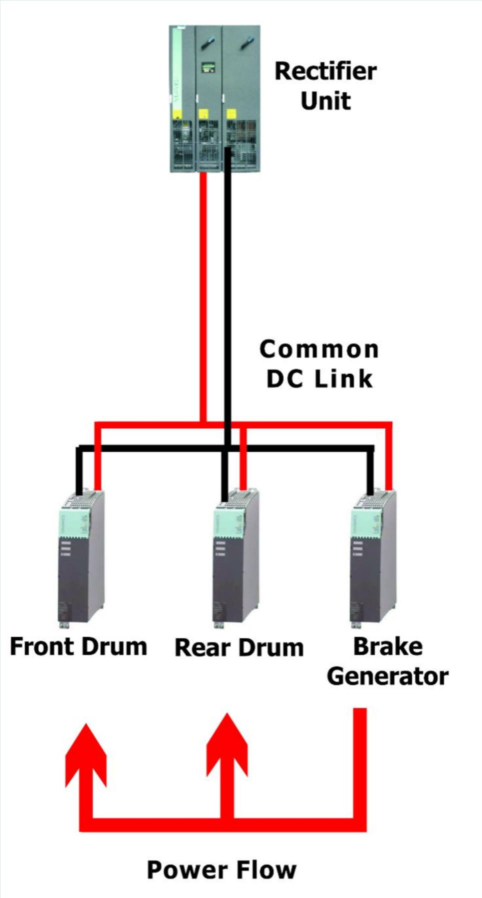
Variable Frequency Drive Setup on the Unwinding Station

When an AC drive is installed on the unwind station, a reverse flow of power is fed back to VFD because the motor is working in a generating mode (as described earlier). As a result, voltage on the DC bus keeps increasing or alternatively, the DC link starts to charge. Within a short amount of time the DC link is charged to a limit the drive can possibly sustain and ends up tripping resulting in a “DC Link Overvoltage fault”. If the VFD trips, the motor loses control producing a in slack in the paper from the lack of a braking action.

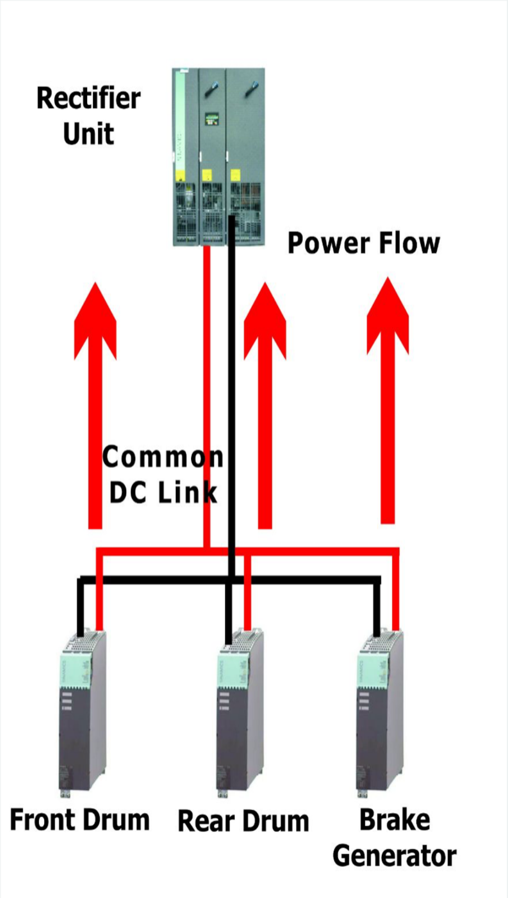
A conventional method to prevent this scenario is to include a properly sized resistance across the DC link to dissipate the DC bus overvoltage in terms of heat. While the tension is maintained, a lot of energy is lost in this process.



What if we utilize the energy from the unwinding station at the rewinding station?



Power Flow from Brake generator to Rewinding Station



Power Flow from Brake generator and Rewinding Station to Supply system

Siemens Sinamics AC drives can help you repurposing the energy generated at the unwinding station at the rewinding station. In this system, both the drives corresponding to each station, work on their respective applications but the DC bus is coupled with each other. The rewinding station can pull in the required power generated by the unwinder through the DC bus.
Additionally the remaining DC bus power after used in rewinding station shall fed back to the supply system. This usually happens at the time of braking. At the time of braking all rewinding and unwinding stations shall remain in regenerative mode and fed the excessive DC Link power to the supply system. One can measure the reverse power flow by using a bi-directional energy meter.

An example of an AEAB proposed solution for a large paper mill in North India

A large paper mill in North India was planning to install a Globe based rewinder with the following specifications:

Motor Data:

- Front Drum: 132KW
- Rear Drum: 132KW
- Brake Generator: 250KW

Automation Requirements:

They also needed a PLC to automatically control the rewinder drive system instead of manually operating it.

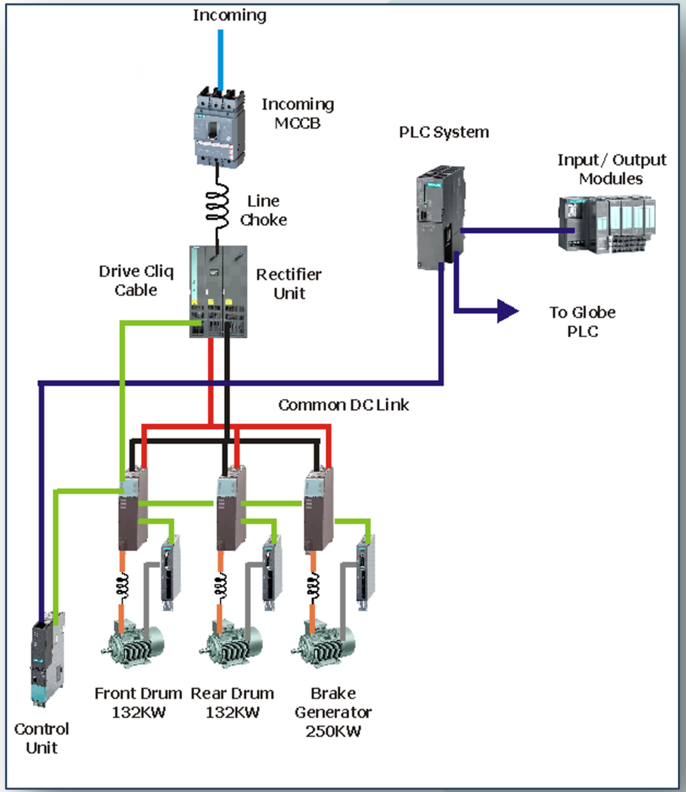
Solution Proposed:

As the Brake generator remains continuously in 100% re-generation, the whole power is utilized to drive the VFDs driving the Front and Rear drum motor.

In the conventional system where a braking resistor included, rectifier power is calculated as follows:

Rectifier Power = Total load connected
Rectifier Power = 132KW + 132KW + 250KW = 510KW

But by using Siemens multidrive system (with a standard size of a 250KW rating), the rating of the rectifier unit optimized resulting in cost savings.



An example of an AEAB proposed solution for a large paper mill in North India

As the brake generator is continuously in regenerative mode, the power consumption in running condition is as follows:

Power consumption	= Rewinding load + Unwinding load
	= 132KW + 132KW – 250KW
	= 14KW
Safety Margin	= 10% of Unwinder load
	= 250KW x 10% = 25KW
Total Power Consumption	= 14KW + 25KW = ~ 40KW
Total current consumption	**= ~ 80-100A**

In contrast, the conventional system power consumption is as follows:

Power consumption	= Rewinding Load + Unwinding load
	= 132KW + 132KW - 250KW (Dissipated in DBR)
	= 260KW
Total current consumption	**= > 500A**

The smallest rectifier unit is rated at 250KW. One may feel the rectifier is under-utilized but if the manufacturer is planning on adding slitter motors, or lead roll motors, or core chuck motors, they can leverage the same rectifier without possibly needing additional capacity.

A multi-axis drive system introduces a variety of opportunities for power savings. At the time of braking all the stations are in the regeneration mode. The excess power available on the DC link is fed back into the power supply network producing additional power savings.

Additionally, a PLC S7-300 system is typically used to automate the entire process of drive system, and this PLC connects to the Globe Radio provided PLC system.

Energy and TCO comparison between a conventional system and multi-axis system

Parameter	Conventional system	Multi-axis system
Power consumption	Higher	Significantly lesser
Energy Saving	No	Yes
Energy Saving during braking	No	Yes
Braking Resistor	Required	Not Required
Capital cost	Lower	Higher
Running cost	Higher	Lower
Rate of return	NA	2-3 years* *Based on mills feedback
Immunity against power fluctuation	Lower	Higher
Accuracy in system	Lower	Higher
Braking time of Rewinder	Higher	Very Lower
Space saving	No	Yes

Parameter	Conventional system	Multi-axis system
Current Consumed	500A	100A
KW considering 0.99 power factor and 415V	360KW	71.5KW
Rewinder Service time per day	15 Hrs.	15 Hrs.
Total kwh per day	360 x 15 = 5400	71.5 x 15 = 1072.5
Per Unit Cost	Rs. 7	Rs. 7
Per day Electricity cost	5400 x 7 = Rs. 27,800	1072.5 x 7 = 7,490
Electricity cost for 365 days	27,800 x 365 = 100L	7,490 x 365 = 27L
Running Cost Saving	X	7X

Automation Engineers A. B. Pvt. Ltd.

AEAB

AN ISO 9001:2008 CERTIFIED

Automating and Modernizing Industry Workflows

www.aeab.in

Solution Partner

Automation

SIEMENS