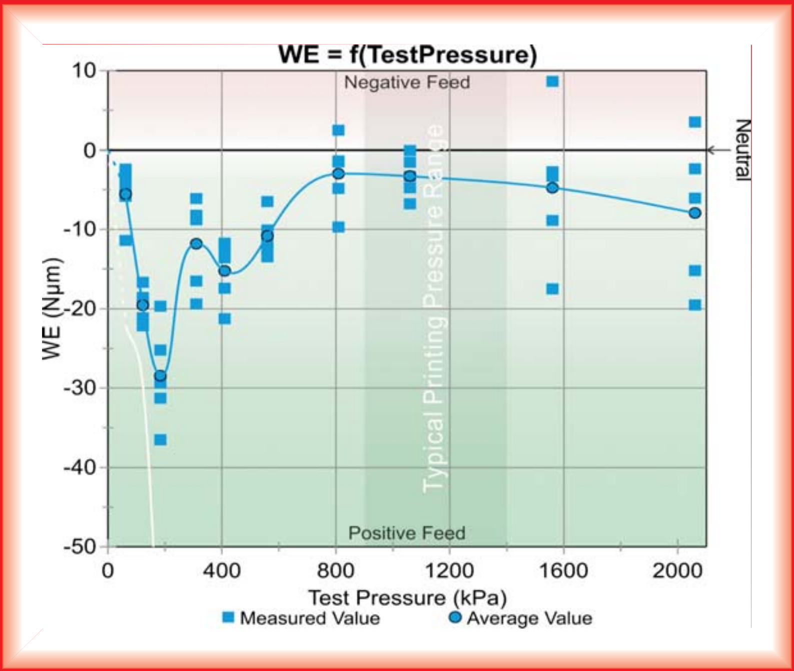
Understanding Printers Blankets



its Layers and Components

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Foreword

History and Outlook

At first sight it may look somewhat embarrassing to pretend that, after over a century since the introduction of printers blankets into the offset printing process and the substantial progress experienced by the printing industry during that period, major novelties related to blanket reaction to cyclic compression still exist, deserving further study.

When the opportunity presented itself, tyre manufacturers used their rubber compounding and processing expertise to extend their production range to printers blankets, which promised an attractive extra revenue.

Blanket design did experience a remarkable evolution, but research needs and costs kept on being pushed-up to what it was sensed to be a disproportionate high percentage of the blanket market volume.

One after the other, all the tyre factories spined-off blankets production from their core business before any of them had produced at least one blanket model based on a sufficiently comprehensive knowledge of blanket reaction to cyclic compression. Blanket industry has consistently been plagued with repeated turmoil, namely economic instability and a countless number of business ownership changes.

Actually, tyre manufacturers' venture into the blanket production left another lasting footprint, with singularly nasty effects for the long-term viability of this industry.

The retail price level originally established early in the XX^{th} century by the powerful tyre industry considered blankets as premium priced consumables - not the specialty printing equipment components they are indeed - at a time the industry was obviously not prepared to benefit from the latest scientific findings.

The blanket's pricing, which prevailed almost untouched for a number of decades, did not afford sufficient room for the one time R&D investment, required to decode the process behind the seeming unpredictability of blanket reaction.

A number of production ventures carried to China by companies seeking lower labour costs, led ultimately to the proliferation of "low-cost blanket" competitors and a sharp decline of the blanket retail price, making it still harder to fund research.

A few exceptions made, the new production challenges posed as from the last years of the XX^{th} Century by the ever increasing Industrial Health & Safety requirements were mostly addressed by blanket manufacturers with a strong commercial component.

Last decades have witnessed, together with a sharp reduction of the blanket manufacturing output, the advent of an unhealthy obsession to cut production costs, often pushed beyond the limits of rationality.

While it must be acknowledged the remarkable progress of the blanket industry, namely in dimensional stability, chemical resistance and printing life, a few features meant to overcome well known issues, successively included in new blanket Data Sheets, keep stubbornly being denied shopfloor confirmation, as it does not yet exist a sufficiently comprehensive master thread of thought covering all the aspects of new model development.

At present, even at the most reputed blanket manufacturers, the tremendous challenges posed to the designer by the eminently multi disciplinary character of printers blankets, are being faced with an unfairly short set of tools, namely solid general culture, sharp common sense and extensive chemistry processing know-how.

But questions unanswered by designers, such as “when a blanket suitable for high speed cold-set presses with satellite configuration will be available” are sooner or later answered by the market.

While no blankets have been available to prevent web driving motors from overloading at high printing speed, alternate means of news diffusion are stepping forward and the sophisticated offset web presses will soon no longer need to rush because printed daily volume is squeezing.

For those printers who have invested on probably the best available offset printing equipment, relying on the ability of the blanket industry to give a positive answer to the market needs, this is a most unfortunate situation, requiring urgent attention.

Also promising digital printing options, applying latest science findings into technological applications, do not discard the use of blankets as a part of the reproduction chain.

Although blankets are clearly a sensitive link in the printing process, they keep on being the preferred option to reproduce high information volumes.

Presently, substrate deformation is the source of register issues that current blanket technology can easily help to solve, but the current uncertainty level of blanket response does not provide a sufficiently solid starting point to encourage further development.

Better blankets, with more reliable performance, will no-doubt appear soon.

It does not make sense to keep on incorporating outdated blanket technology in the digital printing equipments of the future.

There is an obvious need for printers blankets to stop being a major limiting factor in the ability of offset to consistently deliver predictable printing results according to the ever increasing marketing requirements.

The study presented now will enable the designer to choose the levels of reproduction unpredictability and reactivity of new blanket models, while it assists the printer to opt between a good blanket and a complete bluff.

It is up to the graphic businessman to decide the amount of unpredictability (and profit) he is willing to gamble every time he prepares another printing run.

... after a while the cat is simultaneously dead and alive, but if you look the cat is either dead or alive.

Solving a true Cat Paradox

Presentation

Extensive laboratory testing of blanket reaction to cyclic indentation-compression led to a new analytic insight. New tools enable to reduce both reactivity and noise levels introduced by blankets during print.

Scope

The ultimate goal of scientists is to transform any technical problem into a set of equations that faithfully translate system operational conditions - often in the form of material reactions as a function of the applied stresses and respective material constants.

The use of simple models has been enough to develop suitable mathematical tools for isotropic materials.

When composites - much more complex to analyse - were added to the engineering materials range, new methods had to be devised, as on the following example:

> In the seventies when structural metal parts used in air and spacecraft were replaced by vitreous laminates, the eminently anisotropic properties of some layer components and the contribution of each individual layer on the overall composite reaction had to be taken into consideration.
>
> Assuming as starting point College Mathematics and Strength of Materials knowledge and still using very simple models, it was developed a pretty effective analysis based on Tensor Calculus.
>
> The number of the required material constants was vastly increased accordingly, as set down on paper in the *Introduction to Composite Materials*, by Stephen W. Tsai and H. Thomas Hahn.

The additional mathematical complexity, involving sixth grade tensors, was conveniently met by the fortunate availability of the emerging computers and software programming.

But, complex as the analysis was, the study of inter and intra-laminar shear stresses was still left to a more advanced stage. Please note that the immediate involvement into deep mathematic calculus, prior to a detailed problem analysis, makes it hard to grasp the full meaning of complex equation results.

Sophisticated DMA (Dynamic Mechanical Analysis) testing has become increasingly popular to determine the directional properties and thermal response curves of technical plastics, while custom built rotational testing rigs have been used to enable detailed study of stresses and strains at the nip during the printing operation. Some blanket models may already have benefited from such added know-how.

But an empty niche still exists on the market, to be filled by the so much longed for "No Feed" blanket. *No Feed (or even Low Feed) will usually be quite different from Zero (or Neutral) Feed.*

During cyclic compression study, Reactive Energy was detected beyond doubt on the occasional, but stubbornly present, negative values of tan δ associated to blanket hysteresis at low compression test values.

Though the amount of Reactive Energy involved in blankets' reaction to compression is small when compared to Hysteresis, its oscillatory character has a high potential to reach disturbing Resonant Statuses.

(*) - Energy involved in the process but not consumed.

Resonance is the tendency of a system to vibrate with increasing amplitudes at some frequencies of excitation.

Printing rotary movement is the primary and main excitation source of eventual blanket resonant reaction.

When, at the end of each oscillatory cycle, the system retains a surplus of reactive energy, the reaction to the next cycle will have its amplitude increased accordingly, in a cumulative process, ultimately (but often quite quickly) leading to resonance.

The difference between overdamping and reactivity surplus may become extremely marginal and in the limit, similar-to-random noise may be added by the blanket to the original image, along the full span of both the perimeter and the width of the cylinder, in a not repetitive way, so that, even two copies from the same run may have visible noise-added differences.

Resonance under consideration is mainly developed in the blanket's compressible layer, reaching cylinders' contact nip, on the surface of the top rubber layer, where it is finally shaped into the observed resonant characteristics.

Somewhat similarly to ductile gold, silver and copper diamagnetic(*) elements, rubber has very high elongation capacity when subject to tensile stresses.

And like beaten or calendered gold sheets, very thin rubber films with even thickness can also be produced, by spreading or calendering.

Rubber polymers consist on diamagnetic carbon and hydrogen compounds, including eventually sulfur, phosphor, nitrogen, silicon, ..., out of a host of other diamagnetic elements, according to the particular compound. Paramagnetic oxygen presence will keep mostly unchanged diamagnetic compounds' nature.

But the similarity to ductile metals ends there. Rubber will recover its original shape as applied forces are released, in a reaction usually acknowledged as rebound, while pulled wires will obediently keep their extended lengths.

Initial acquaintance with the extremely peculiar - liquid like - rubber reaction was made by appraising, in no hurry, ocean and seismic waves behaviour.

The main difference is that while the energy associated with ocean and seismic waves travels and dissipates respectively on the shores or on earth crust(**) modifications, when the external excitation ends, rubber reaction(***) - under the form of energy bouncing associated to the oscillatory movement - will damp to equilibrium and matter will recover its original coordinates.

Although it is usually taken for certain that elastomers have damping properties, vibration generated during the printing process, both in the press and inside the rubber composite structure, will only be kept under control if blanket design includes specific provisions to achieve that effect.

(*) - Further to most electrical conductors, study of the quite peculiar diamagnetic reactions to applied stresses is often associated to the so called Sciences of the Nature, such as meteorology and hydraulics.

(**) - On a geological scale some soils will behave like highly damped fluids.

(***) - For most applications, usually defined material constants do not apply to the eminently nonlinear reaction characteristics of rubber and to its extremely low modulus to tensile stresses. Those constants become now functions of the instant value of the applied stress.

Features

A Reactive Energy Response Curve as a function of compression loads was built-up in our laboratory, over a complete printing pressures range, having revealed itself a basic tool for blanket reaction analysis.

Testing of 200+ blanket model samples originated a variety of response curves, spread, not only over a relatively wide range of values, but also, depending on the model, over a quite variable results' dispersion.

When a specific phenomenon can be represented by a graph which shape is unique, then such unique graph shape will unmistakably denounce the presence of that specific phenomenon.

All the graphs of cyclic compression testing presented a common pattern at their low pressure segment, rising to a peak around 200 kPa, followed by a sharp decrease, characteristic of resonance:

Current compressible blankets have in common a non negligible oscillatory reaction component.

Early in the XXth Century a trend developed on both sides of he Atlantic to apply the existing electrical circuits knowhow to the analysis of mechanical systems subject to periodic motion.

> After extensive study, Harry F. Olson published a Dynamic Analogies manual establishing mechanical and electrical pairs of elements. The 2nd edition of this book, issued during World War II, acknowledged the merits and described the Mobility or **Inverse Analogy**, devised by Floyd A. Firestone.
>
> With this Analogy the basic electrical elements - Impedance is a general concept encompassing resistance, inductance and capacitance - are replaced by its inverses. Admittance is the inverse of Impedance and **Admittance has a direct mechanical equivalent, the Compliance**, contrarily to the traditional elements considered in the previous analogies.

One main advantage of this approach is to enable the previous breakdown of rubber and blanket complexity into the analysis of a set of Basic Concepts like

> Applied Frequency, Fundamental and Harmonics; Interference(*); Filters & Boosters, or Dampeners & Resonance Boxes; Domains and Frontiers; Dominant Layer Response and how to shape its Character; Spring & Dashpot; Spring & String; Released & Tensioned fibres; Positive and Negative Reactivity (clearly reminding Positive and Negative Feed), used during our study.

before plunging, mostly illiterate, into the sand desert of mathematical development.

Please note that the driving source of every Offset press includes at least one AC electric motor.

Electric motors are transducers that convert the incoming electric energy of the mains into the rotational mechanical movement of its output shaft.

The shaft of the motor describes a *Periodic Circular Movement* while AC stands for Alternating Current, with its inherent *sinusoidal Oscillatory Character*.

Every press manufacturer knows that special care must be taken to avoid vibration and running problems. We are simply confirming that blanket production and handling is no exception.

Web press printers using Sleeve Blankets are well aware of the impossibility to match blankets which Compliance figures fall too far apart.

"Understanding Printers Blankets, its Layers & Components" sets the minimum starting knowledge enabling the development of, at least, the mathematical base models required to study blanket response.

(*) - A few instances of Interference are Beat Frequency, Feedback, Stationary Wave, Modulation and Inter-Modulation

The result is a set of blanket design recommendations, meant to bring under control a variety of the blanket composite reactions, generated by its elastomer "alloys", layer component arrangements, relative proportions and combinations, that finally reach the printing interface.

A further feature of our study, with significant economic value, was the identification of a convenient Reduced Model, ready to be used during the blanket design process.

Challenges

The recommendations resulting from our interpretation of blankets' response to cyclic compression are extremely simple to grasp and to gain unanimous acceptance.

However and unlike what is mentioned above about the univocal correspondence between a specific phenomenon and a characteristic graph, any modification procedures ought not to be started before a truly comprehensive blanket behaviour understanding is achieved.

It must be assured that all the other possible sources of internal perturbation, as extensively identified on the main text of our study, will not mask the results of that particular modification, as it so often still happens in the present days, misleading the designer into despair.

The Analytical Scale, an old tool fundamental to creating top quality vitreous composites, but oddly deprecated by blanket manufacturers, will be of invaluable assistance during blanket redesigning process.

Measures to control blanket reactivity will only be effective if strict tolerance limits, both for composite layer thickness and industrial process steps, are introduced and consistently observed batch after batch.

A single sentence summarises the findings of our research:

Practical design provisions can prevent, or at the very least substantially mitigate, blanket resonant reactions' buildup during the print operation.