Impact Of New Generation Hot Forging Lubricants On Forging Quality And Die-Life

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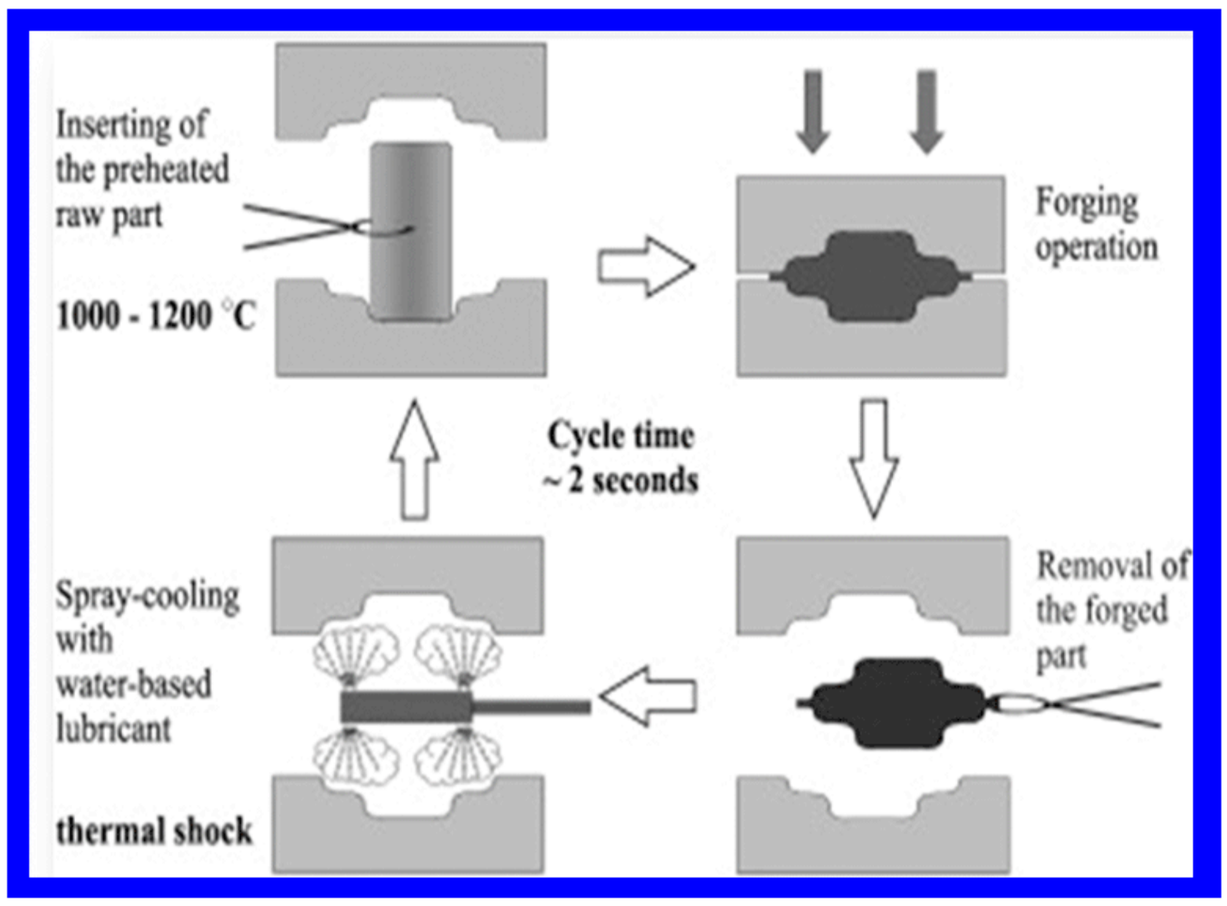
ABSTRACT

Hot forging involves controlled plastic deformation of heated metals and alloys into desired useful shapes. Hot forging is mainly carried on forging presses and hammers. Forging lubricant plays an important role in hot forging, making forging process possible. The selection of proper forging lubricant plays a vital role in achieving successful forging process. The primary function of a forging lubricant is to increase productivity and profitability of the forging company. The task of an efficient forging lubricant is To carry out the forging process within the limits and parameters considered by the forging industry by preventing catch-ups, maximizing die life, decreasing the number of rejects and reducing the load on forging equipment.

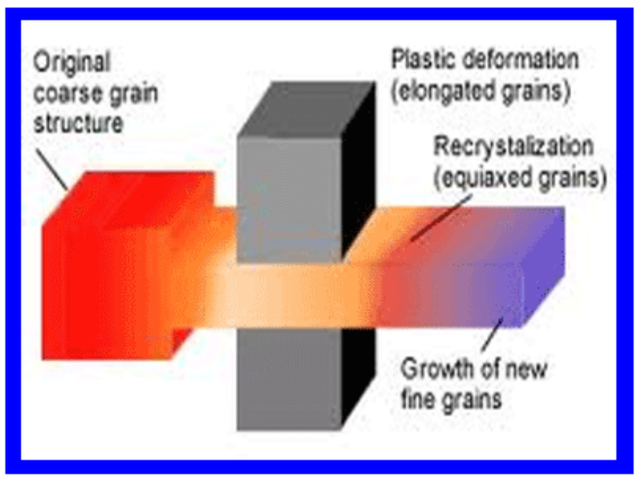
INTRODUCTION

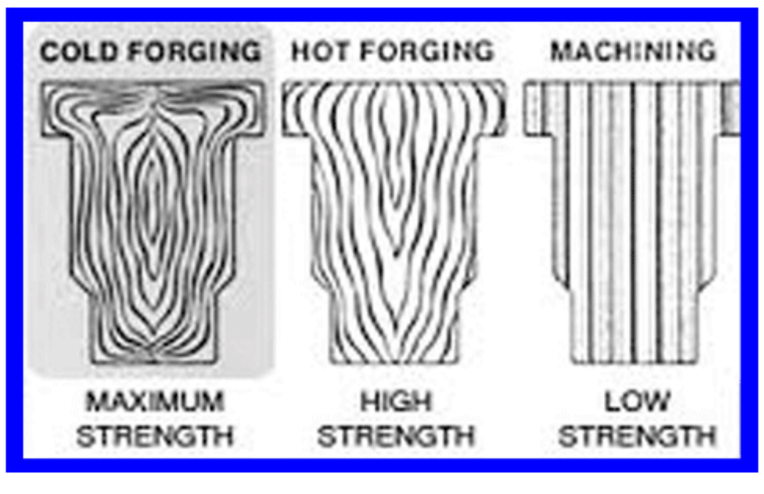
Forging is a deformation process of material through compressive stress. Forging has several advantages. Closer dimensional accuracies achieved require very little machining after forging resulting in material savings. Higher strength, greater productivity, favourable grain orientation, high degree of surface finish are other merits. However, complex die making is costly. Forging is carried out either hot or cold. Hot forging is done at temperatures above recrystallization temperatures > 900 0C, Warm forging is done in the temperature range 450 ~800 0C. Cold forging has advantages such as good surface finish, high strength and greater accuracy. Hot forging requires lower loads, because flow stress gets reduced at higher temperatures. Typical applications of forging include bolts, disks, gears, turbine disk, crank shaft, connecting rod, valve bodies, small components for hydraulic circuits etc.



Open die forging
Closed die forging
Precision die forging

Flashless forging
Roll forging
Rotary forging





Advantages of Hot Forging

- Increased ductility in hot forged components makes them
  desirable for many configurations
- The excellent surface quality allows a wide range of finishing work as polishing, coating or painting, tailored to customers' specific needs.
- Good strength
- Do not cause work hardening which is an additional advantage for easy machining

Disadvantages of Hot forging

- The cooling process should be also performed under special conditions; otherwise there is a risk of warping
- In the case of hot forging, a high temperature furnace will be required to heat ingots or billets
- The safety requirements in working with hot metal
- Capital cost is more
- Very high man and material safety procedures need to be followed

Expectations From Hot Forging Lubricant

- Avoid sticking of forging component in die cavity
- Reduce forging load
- Provide better surface finish
- Maintain proper die temperature
- Improvement in die life
- User friendly
- Economical
- Non-Abrasive and Non- Corrosive

Types Of Hot Forging Lubricants

Graphite Based

- **Graphite in water dispersion.**

It's a suspension of ultra-fine graphite powder with special additives. Most commonly used die lubricant.

- **Graphite in oil dispersion.**

These are basically suspension made with oil, graphite and special additives as per forging process lubrication demand. Most used for the hammer and deep extrusion forgings.

Non-Graphite Based

- **Synthetic compounds based on organic salts.**

- **Solid lubricants dispersions based on MoS2, Boron Nitride, Glass.**

It consists of soluble salts and polymers which perform under less severe conditions, requiring a lower degree of lubrication.

Parameters to be monitored in Forging lubricant

Concentrate Product	• Type of graphite • Graphite Particle size • Ash content. • Total solid content and graphite content. • Viscosity and pH of the concentrate.
Check Points In Diluted product	• Need to set the dilution based on the application and maintain the same during continuous usage • Need to check the solution during continuous agitaion in mixing tank
Set parameters during application	• Lube spray Time • Spray Angle • Size of the lubricating drop • Output and distance from the lubricating point to the areas to lubricate
Factors affecting the film formation	• Degree of dilution of the concentrate • Density of the lubricant mist • Temperature of the die • Pressure of the application of the lubricant over the die
Factors affecting the Die life	• Pressure forces applied to the process • Speed of the metal flow • Type and composition of metals forged • Type of metals and treatments employed in the dies • Friction coefficient imparted by the lubricant

Methods of application

Swabs, mops, brushes and cloths

Sprays

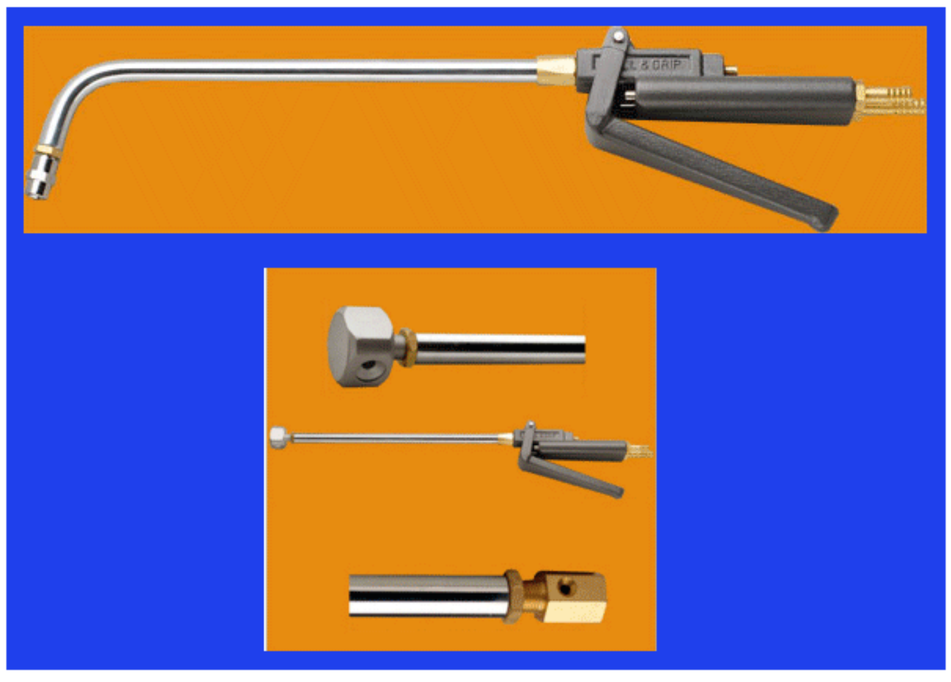
- Hand held spray gun
- Fixed auto spray system

Reciprocating Spraying Machine: Generally it is used for medium to large impressions of complex configuration and for volume application applied with programmed spray arms.

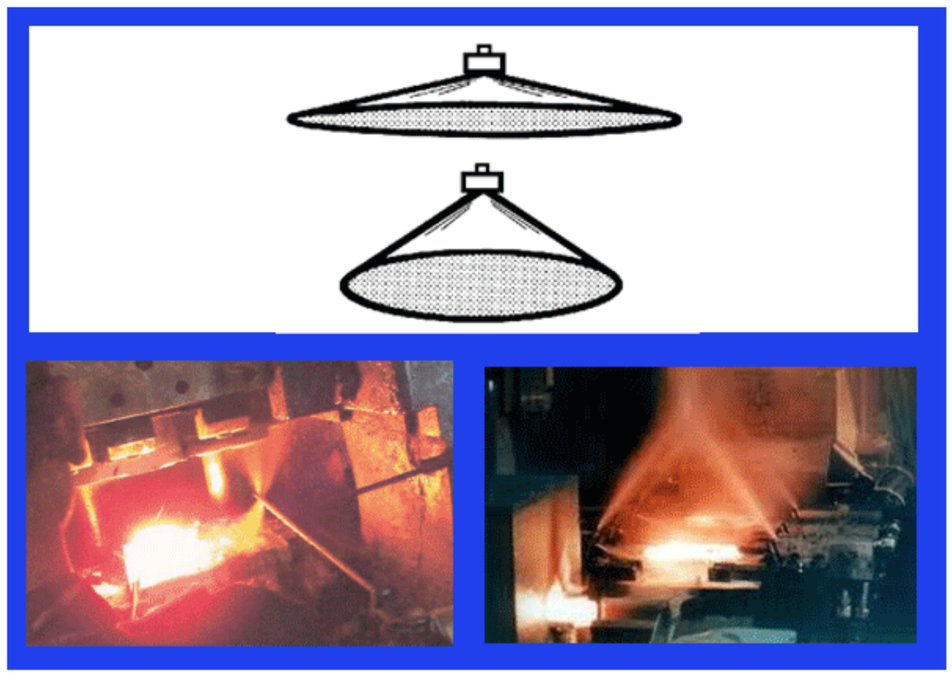
Pumping/Flooding: It is used for special extrusion processes or extremely high volume application of water or oil based lubricants.

Pre-Coating: Generally used for protective or glaze coatings as batch processes like electrostatic spraying, dipping or plating

Spray Gun & Spray Angles



Different Type of Spray Guns



Spray Angles & Types

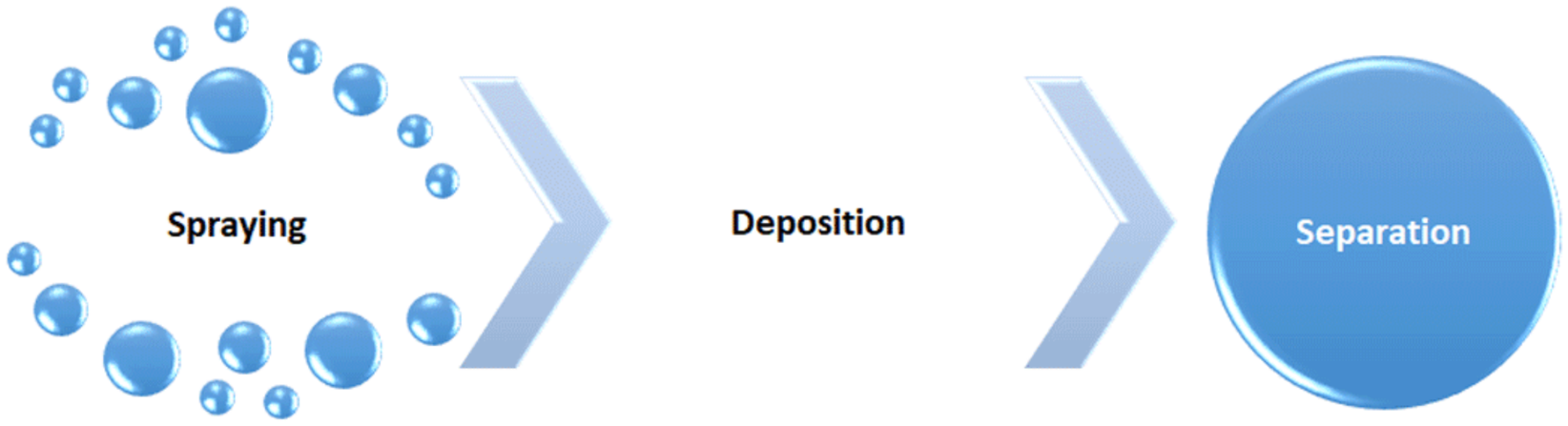
Mixing

- The recommended dilution ratio depends on the difficulty of the job and the cooling requirement. For initial trials a ratio of one part product to ten parts water (1:10) by volume

- The most economical dilution ratio can only be determine after evaluating all of the production parameters, but is normally between 1:5 for very difficult or hot dies and 1:20 (or greater) for very simple dies

Mixing Tank with Spray Gun

Forging Lubricant Working Principle



- Pressure
- Nozzle
- Dilution Ratio

- Adhesion
- Cooling
- Lubrication

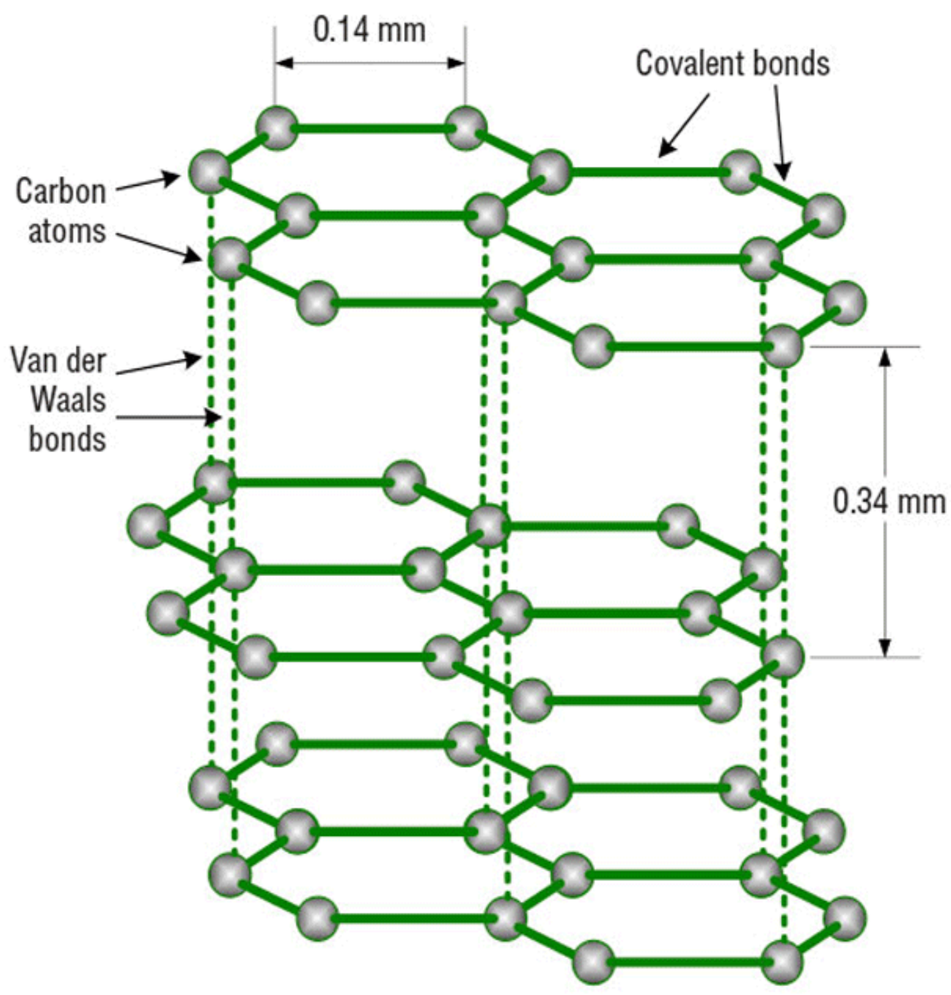
Release & Surface Finish

Advancement in Hot Forging Lubricants Technology

The forging industry has been traditionally using conventional forging lubricants. In the conventional forging lubricants the nature of graphite particles as well as distribution of particle size varies, the ash formation is high and the adhesion properties are inferior.

More than ever, today there has been a growing concern on productivity enhance-ment and at the same time focus is on overall cost economics. In order to fulfill these requirements, new generation forging lubricants have been developed.

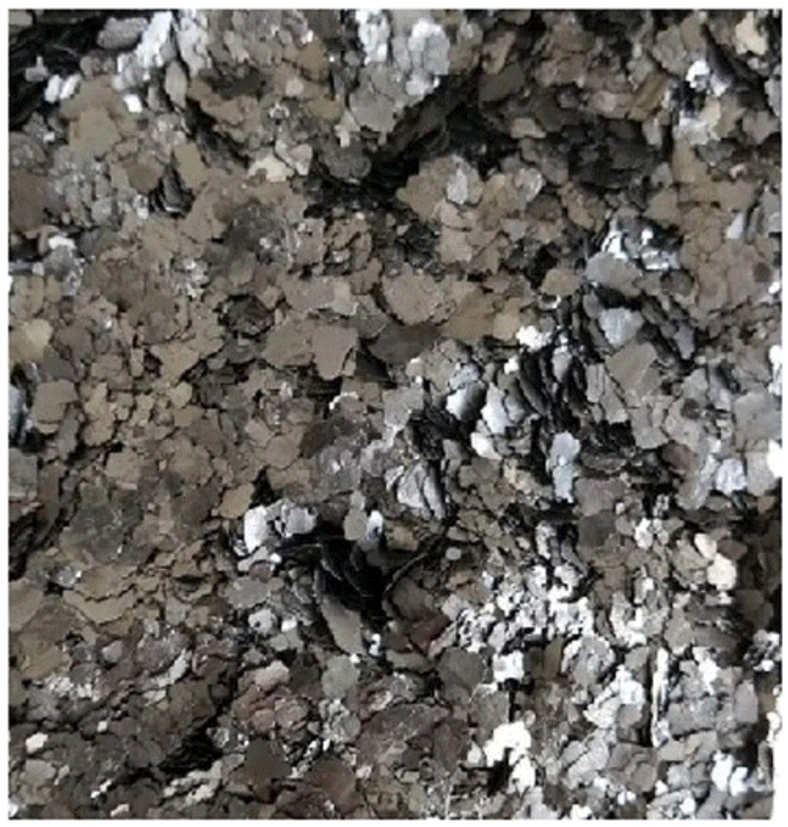
Structural properties of graphite used in new generation forging lubricant are shown below.



New generation forging lubricant promotes better metal flow and is more lubricious. Products consisting of graphite have a hexagonal lattice structure. Imagine a thin slice of a honeycomb placed at a certain distance over another slice, which in turn is placed over the next and so on, with each vertex of each hexagon representing a carbon atom. The layers of the lattice are bound to the adjacent layers by weak van der Waals bonds, which allow the layers to slide over one another easily, like a teetering pile of paper sheets (above Figure). Thus, the quintessential properties of graphite – softness and slipperiness – that make for an excellent solid lubricant are obtained. Such phenomena is not observed in conventional grade.

Shown below are the magnified impression of graphite which is a key differentiator in achieving final performance.

Conventional State



Modern Technological State

The new generation graphite forging lubricant has more adhesion and produces better part surface quality. It contains a binder that holds the graphite particles to all surfaces of the die and reduces the amount of overspray. Most conventional products create a soft film on the die surface which usually hold the scale and affect the surface finish.

Comparison between Conventional Vs. New Generation Hot Forging Lubricant

S.no	Detail	Conventional Product	New Generation Product - Hilubric FW 02 M	Remarks
1	**Type of grade**	Water based colloidal Graphite	Water based colloidal Graphite	
2	**Mixing Ratio**	1 :10 ~ 1:20	1: 10 ~ 1:25	Depends on Severity, dilution will vary.
3	**Appearances**	Smooth liquid, Black, Thixotropic	Smooth, Black, Thixotropic	
4	**Film formation Tes**			Even film formation

Benefits Of New Generation Forging Lubricant Over Conventional Lubricant

Main Characteristics	Advantages	Benefits
Highly purified graphite with fine particles	Higher dilution ratio & better performance	Good lubricity and metal flow
Optimized binder	Good wetting and adhesion properties	Uniform film formation
High temperature stability	Less ash/ Scale formations	Shear resistance and easy flow
Good stability of concentrate	Good lubrication	Improved die life &
Stable pH	Non corrosive in nature	Excellent releasing properties. protection of tanks, pipes and machinery parts

CASE STUDY: 1

CUSTOMER	One of the leading manufacturer in South India, producing steel forging in raw, semi-machined and fully machined stages. They are manufacturing and supplying components like axles, flanges, spindles, hub, Cross shafts, etc. to industries like automotive, oil field & industrial segment.
TRIAL OBJECTIVE	1. Less scale formation in die 2. To achieve the required die life – 4600 rods 3. No die catch-ups in flange component (30% of the production) 4. Better surface finish-Visual finish with no wrinkle marks/cracks 5. To reduce the overall CPC-10 % from existing (existing CPC-Rs.0.30)

APPLICATION/OPERATING DETAILS

1.	Press	KB Press
2.	Load	1600 Tons
3.	Part	Flange Housing
4.	Material	Steel(30MNVS6)
5.	Billet Size	Dia :34 mm , Length : 178 ~ 180 mm
6.	Die life	4600 rods
7.	Die Polish	Once in a shift
8.	Billet Temperature	1150 Deg C
9.	Dilution Ratio :	1:20 ~1:30, Manual Spray with Agitated tank

COMPONENT

PRODUCT RECOMMENDED	Hilubric FW 02 M
TRIAL RESULTS	✓ Less die catch up as compared to earlier & good ejection after forging. ✓ Less scales observed compared to Existing product ✓ Average die life achieved 4800 numbers ✓ CPC Achieved 0.28 Rs/part ✓ No Wrinkle marks and no cracks observed(Quality check 2times/shift visual)

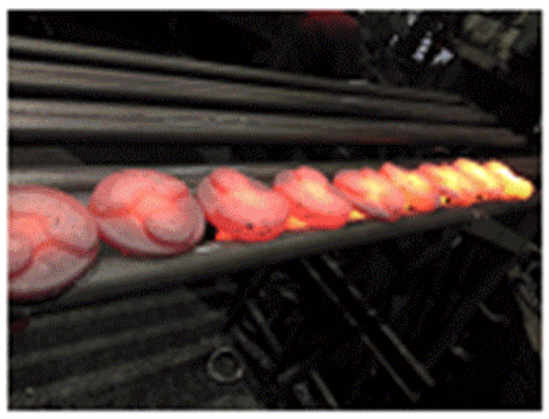
CASE STUDY: 2

CUSTOMER	One of the leading manufacturers of forged parts in North India and supplying components to major OEMS and industrial segments.
TRIAL OBJECTIVE	1. Less scale formation in die 2. To achieve the required die-life 3. No die catch-ups in critical parts 4. Better surface finish-Visual finish with no wrinkle marks/cracks 5. To reduce the overall Cost / kg (existing Cost / kg- Rs. 0.50)

APPLICATION/OPERATING DETAILS

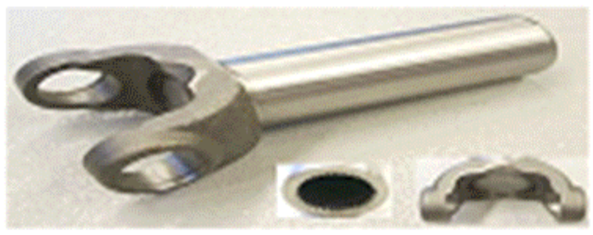
1.	Press	Anul Press
2.	Load	1600 Tons
3.	Part	Crank shaft
4.	Material	Steel(S48C)
5.	Billet Size	Dia- 46 ~50 mm, Length – 108 mm, Weight – 1 kg
6.	Die Polish	After 1500 parts
7.	Die life	4000~5000 parts
8.	Die Temperature	150 ~180 Deg C
9.	Billet Temperature	1070 Deg C
10.	Existing Dilution Ratio :	1:10, Mixing tank : air Agitation & Manual spray (Double side spray gun)

COMPONENT



PRODUCT RECOMMENDED	Hilubric FW 02 M
TRIAL RESULTS	✓ Less die catch up as compared to earlier & good ejection after forging. ✓ Less scales observed compared to Existing product ✓ Average die life achieved as per existing and die polish done after 2000 numbers ✓ Cost per kg Achieved Rs. 0.36 ✓ No Wrinkle marks and no cracks observed

Other applications where the new generation hot forging lubricants have outperformed the conventional products

S.no	Component	Study Results
1		✓ Achieved required finish ✓ Improvement in Die life – 5~10 % ✓ Less Die catch ups ✓ Die polishing frequencies reduced – Improvement in productivity ✓ Good stable solution ✓ Even film formations ✓ Less smoke ✓ Less scale formations.
2		
3		
4		
5		
6		
7		

Conclusion

By careful selection of modern new generation hot forging lubricants, significant improvement in forging quality and die life can be achieved in comparison to the conventional forging lubricants. Thereby achieving the requirements of safer working conditions, cost economical solutions, improved productivity and enhanced quality.