



Industry Case Study: “Establishing Sustainable Pharmaceuticals in India: Opportunities and Challenges”

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Our Journey



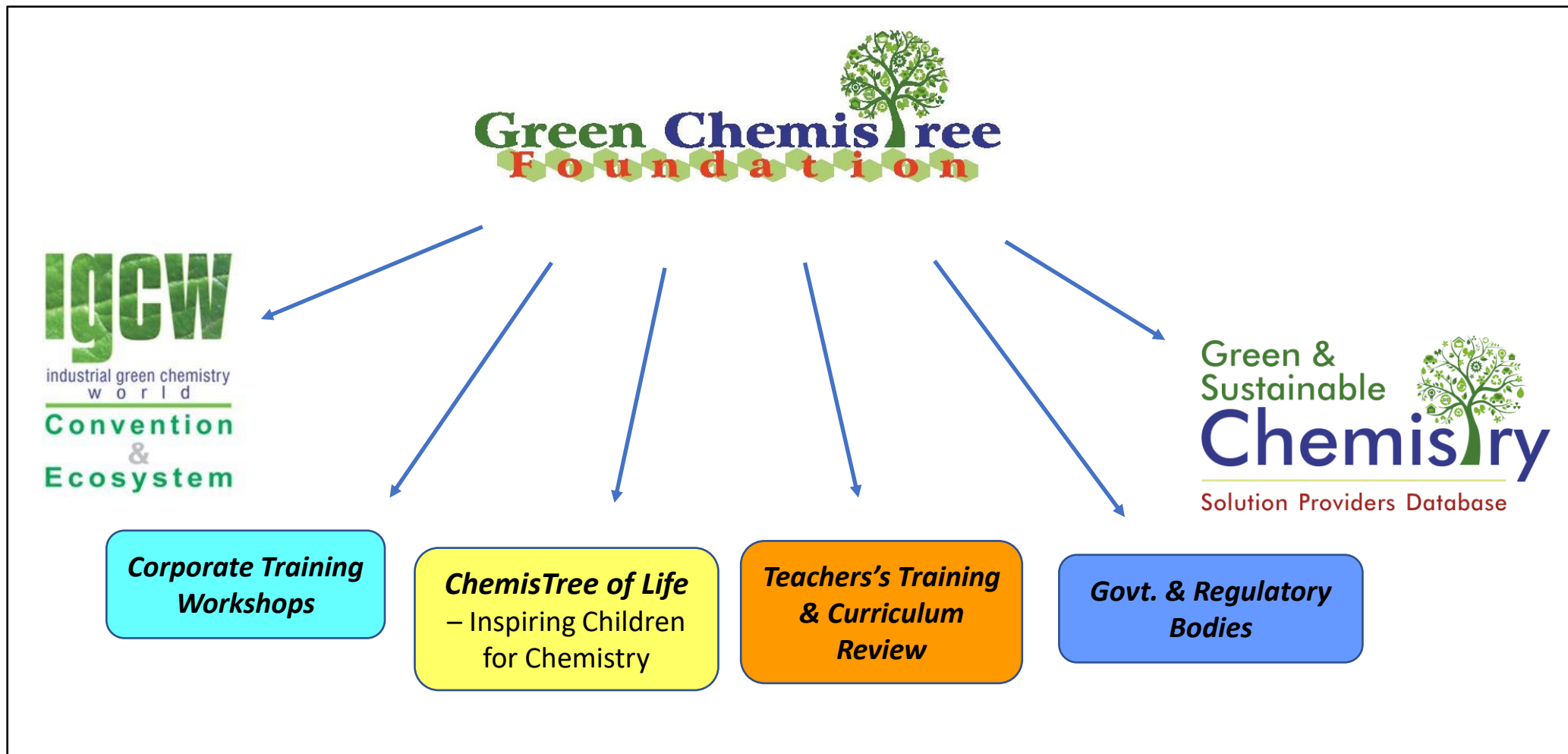
- For-profit organization, Founded by IIT-Bombay technocrats (early 2000), Met during Tree Plantation
- Passionate about Nature & committed to environment
- 75 people team now (35 chemists & chem. engineers)
- Customizing, scaling-up & commercializing Green & Sustainable Chemistry Solutions
- Interest in Sustainable Metal Catalysis **especially Iron/Iron Oxide-based**



- Inspired by GC&E Conference, 2008
- Registered not-for-profit organization (2009)
- Committed to accelerating implementation of GC&E in Chemical Industry
- Engaging with all stakeholders (industry, government, regulatory, academia, students, policy makers, media, etc)
- Diverse Initiatives - Collaborating with international agencies (ACS-GCI, ACS-GCI Pharmaceutical Roundtable, Beyond Benign, ISC3, Centre for GC&GE at Yale, etc)
- Industrial Green Chemistry World (IGCW) – Key Initiative



Green ChemisTree Foundation: Our Initiatives

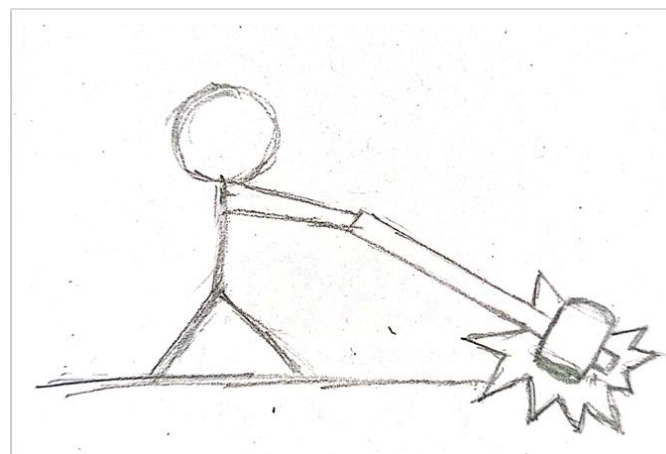




Commercialization of G&SC Technologies

Why this commitment to Commercialization?:

- That's what creates impact at the ground level
 - Quality of environment – quality of air, water or soil
 - Quality of life – safer processes & products
 - Sustainability of life on plant
 -





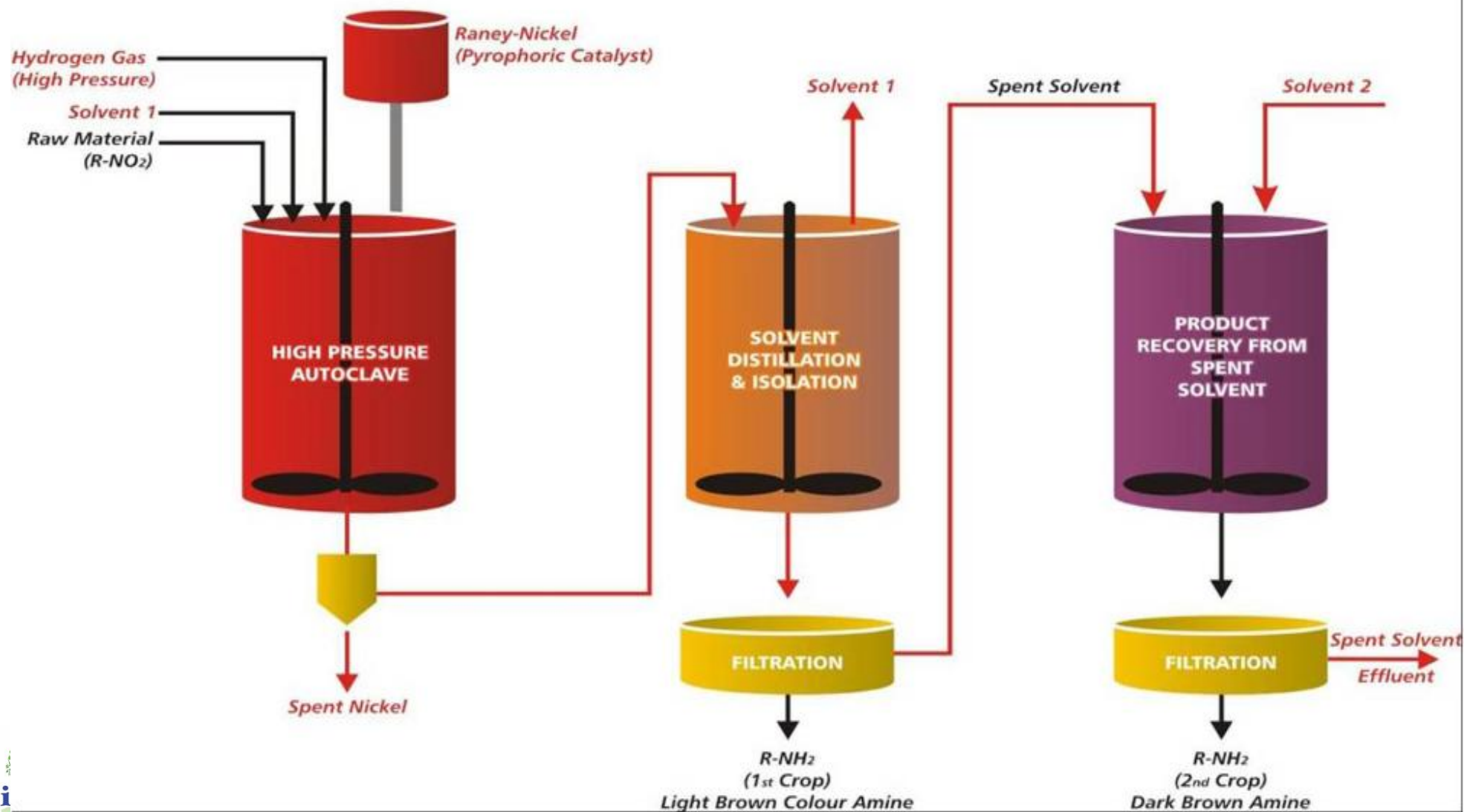
Industry Case Study 1: Green & Sustainable Chemistry in Process

Industry	Pharmaceutical
Customer	A fast growing Pharma Company in India
Product	Anti – Retroviral (or Anti – Aids) Drug
Application	Prevents transfer of virus from mother to child
<i>Customer's Concerns</i>	Safer process, Reduce batch time and cost



Industry Case Study 1: Green & Sustainable Chemistry in Process

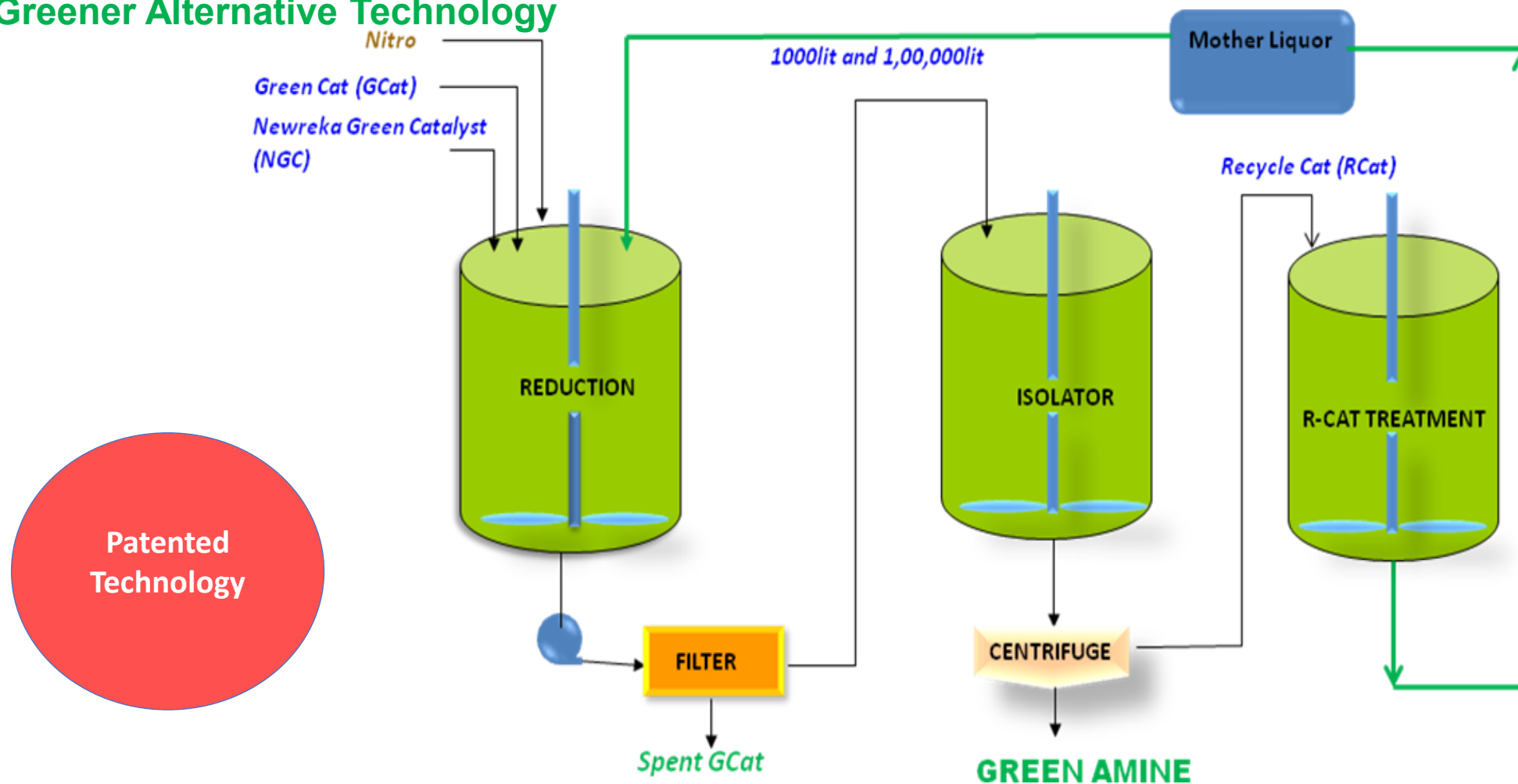
Conventional Technology: High pressure catalytic hydrogenation / Raney Ni





Industry Case Study 1: Green & Sustainable Chemistry in Process

Greener Alternative Technology



Feedback from customer: Recycled mother liquor for over 2.5 years, Over 800 batches. Just make-up for Water loss (saved over 1mn lit fresh water)
Amine Quality – 99%+ on HPLC, 10% Yield improvement



Industry Case Study 1: Green & Sustainable Chemistry in Process

Impact:

- Inherently safer process – Water as reaction media, no MeOH or high pressure H₂, no pyrophoric catalyst, Atm. Pressure reaction
- Inherently environmentally friendly process
- Zero waste – water completely recycled, Spent Reducing agent to Cement, no air pollution
- Economically competitive process – 10% increase in yield, savings in RMC and lower waste management cost
- **Triple Bottomline – People, Planet & Profits**



Mylan Laboratories Limited
(Formerly known as Matrix Laboratories Limited)
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Hyderabad - 500 034, Andhra Pradesh, India
Tel: +91-40-30866666, 23550543, Fax: 30866699

LETTER OF ACKNOWLEDGEMENT & APPRECIATION

29th Oct'2013

We, at Mylan Laboratories Ltd., implemented Newreka's Recycle@Source™ Solution at one of our CMU location for one of our Pharmaceutical Intermediates (an anti-retroviral drug) at commercial scales.

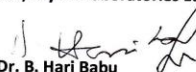
We were earlier using high pressure catalytic hydrogenation with Raney Ni & Hydrogen gas for a Nitro to Amine reduction in the above intermediate. This conventional technology was replaced by Newreka Reduction Technology (NRT) which offered us following advantages:

1. *Water based process* – eliminated use of solvents
2. *Safer reaction conditions* – atmospheric pressure & nominal temperature & pH
3. *Safe reducing agent* – freedom from handling of pyrophoric catalysts
4. *Higher selectivity& yield in reduction* – no knock off of halogen group while reducing nitro
5. *Complete recyclability of aqueous layer back in to reduction process* – **the mother liquor obtained after isolation of Amine was completely recycled back for over 800 batches in the plant.**
6. *Consistent quality of amine* – Even after 800 times recycle of mother liquor, the quality of Amine is 98%+ on HPLC consistently.
7. Over all economical process compared to Catalytic Hydrogenation with Raney Ni.

Inside of Mylan's commitment towards environment & sustainability, we implemented Newreka's Green Chemistry based solutions and are proud to have saved millions of liters of fresh water by using Recycle@Source™ Solution and recycling aqueous mother liquor more than 800 times over a period of last 3 – 4 years that we have continuously used this technology for commercial production of our API (Active Pharmaceutical Ingredient) Intermediate.

We take the opportunity to thank the Scientists and Management of Newreka group for their best efforts and commitment towards greener synthetic methodologies

For, Mylan Laboratories Ltd.


Dr. B. Hari Babu

CEO & MD



E-Factor in Pharma Industry

Sector	E - Factor	Product Tonnage
Oil Refining	≤ 0.1	$10^6 - 10^8$
Bulk Chemicals	1 – 5	$10^4 - 10^6$
Fine Chemicals	5 – 50+	$10^2 - 10^4$
Pharmaceuticals	25 – 100+	$10 - 10^3$

Source: R A Sheldon

Nature of Pharmaceutical manufacturing:

- Complex molecules & multi-step synthesis
- Chemistry Intensive processes & low process yields
- Stringent quality & regulatory requirements
- Use of classical stoichiometric reagents

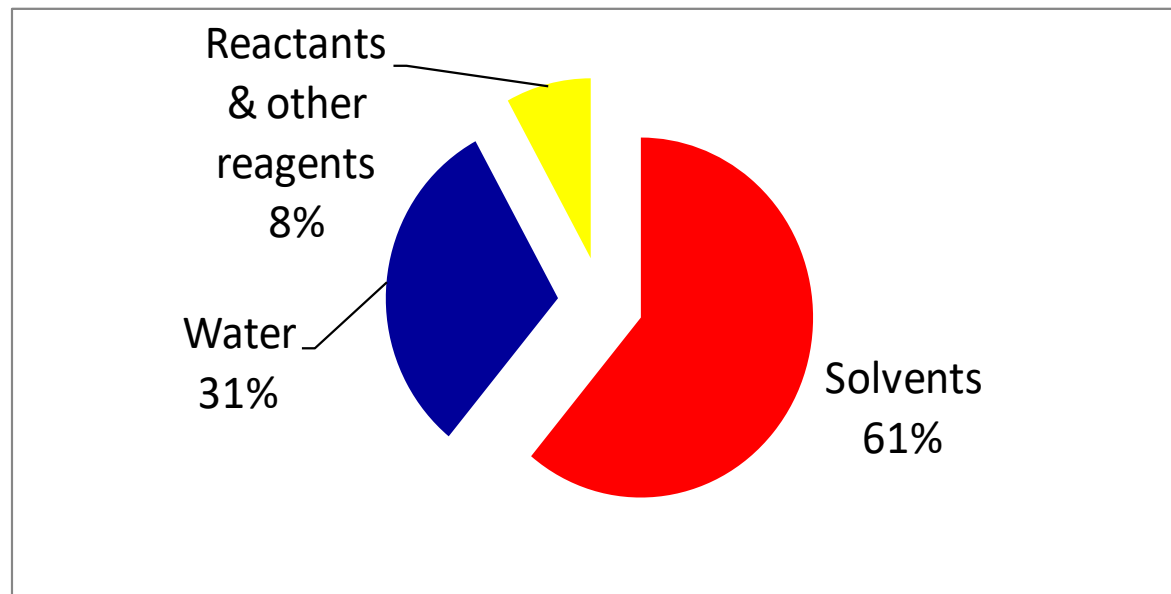
The above leads to **High E - Factor or Environmental Impact Factor** (defined as kg of waste / kg of product).

Need to explore ways to address this challenge of high E - Factor.



E-Factor in Pharma Industry

Solvent & Water contribute more than 90% of the Reaction Mass



Source Data: ACS GCI Pharmaceutical Roundtable benchmarking exercise 2007

Most cases, average composition of Effluents will be close to composition of reaction & extraction medium.

Recycle of reaction & extraction medium & Recovery of by-products can take care of 90% of effluent problems.



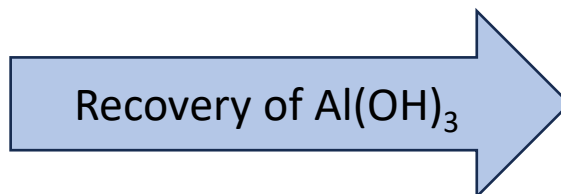
Industry Case Study 2: Recovery of Chemicals from Waste Streams

Waste Stream Details:

Source	Fridel Craft Acylation using AlCl_3
Quantity	11 MT/day
pH, TDS, COD	< 0.5 (highly acidic), 258460 ppm, 31699 ppm
$\text{Al}(\text{OH})_3$ Content	10.7%



Wastewater



$\text{Al}(\text{OH})_3$

Quality of Recovered $\text{Al}(\text{OH})_3$:

Sr.No.	Test	IS: 10896-1984	Result	Remarks
1	Appearance	White (Powder)	White (Powder)	Complies
2	Al as Al_2O_3 (%W/W)	Min 65%	66.60%	Complies



Adopting Green & Sustainable Chemistry in Pharma Industry

Barriers:

- Stringent quality requirements – recycling water, distilled solvent is challenging
- Product for direct human consumption – high stakes
- Regulatory limitations – DMF already filed, difficult to change
- Customer approvals for any process change
- Supply chain largely MSMEs – doing early-stage processes, diverse constraints, difficult to manage Scope 3
- Many inherently polluting chemical processes – No Greener alternatives available
- Economics – not pressing (good margins, yield improvement or saving of treatment costs doesn't provide enough drive)



Adopting Green & Sustainable Chemistry in Pharma Industry

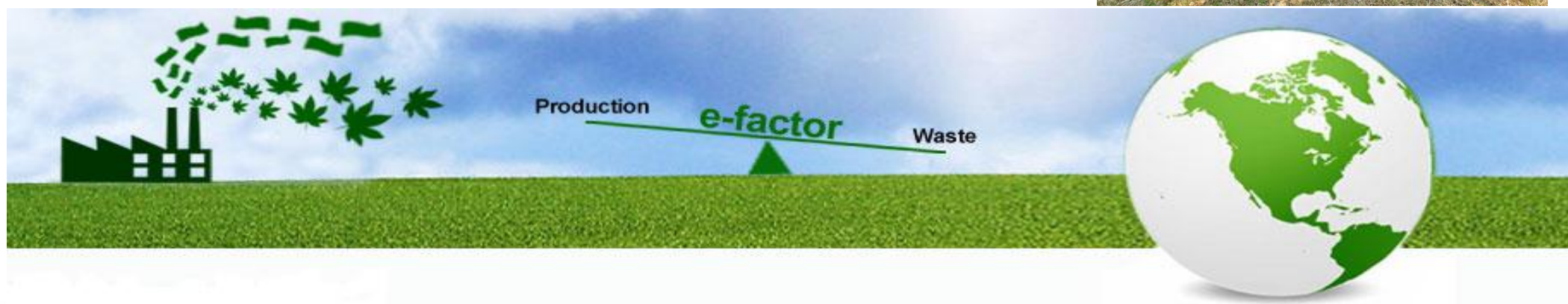
Opportunities:

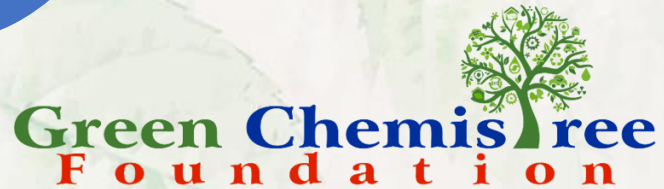
- Developing new greener alternatives – Opportunity for academic collaboration
- Exploring emerging technologies – Biocatalysis, Flow Chemistry, Electrochemistry, Photochemistry, etc
- Substantial gaps in yields, solvent & reagent consumptions, recyclability of catalysts, etc.
- Reduced costs of waste treatment, incident compensation, investments for safety
- Exploring Green Chemistry route at medicinal chemistry level – easier changes in regulatory filings, easier customer approvals
- Backward Integration – safer & inherently benign processes can be done in-house
- Cost competitiveness, reliable supplies, higher trust & relationship with stakeholders



Thank you & wish you a Greener Future

www.industrialgreenchem.com





Introducing the **Green & Sustainable Chemistry** Solution Providers Web Portal

Accelerating implementation of Green
and Sustainable Chemistry.



A Shared Vision. A Common Challenge.

The Challenge We Face

- › Lack of awareness and accessibility of Green chemistry solutions and expertise
- › Industry players struggle to identify credible, ready-to-implement solutions for their environmental challenges
- › Solution providers lack visibility and access to scale
- › Lack of common platform to converge organizations developing solutions and those seeking them



The Future We Envision

- › Green chemistry becomes the industry default, not the exception
- › Safer products and cleaner processes across every supply chain
- › Innovation that protects both human health and the planet
- › A global ecosystem where knowledge and impact are shared freely



CONNECT | COMMUNICATE | COLLABORATE | CATALYZE | COMMERCIALIZE



This is the gap we set out to bridge, with a platform built for connection and collaboration.

Connecting Solution Seekers to Solution Providers

The screenshot shows the login interface of the Green & Sustainable Chemistry Solution Providers Database. At the top, there is a navigation bar with links for Home, About us, Categories, Companies, and Contact us, along with a Login/Sign Up button. The main content area is titled 'WELCOME' and prompts users to enter their email and/or phone number to login. It features a central login form with a 'Remember me' checkbox and a 'Login with OTP' button. To the left, a list of potential solution seekers includes the Chemical Industry, Industrial Associations, Govt. Regulatory Bodies, and NGOs. To the right, a list of potential solution providers includes Innovators, Researchers, and Technology developers. Arrows point from these lists towards the central login form.

Green & Sustainable Chemistry
Solution Providers Database

Home About us Categories Companies Contact us Login/Sign Up

WELCOME
Please enter your E-mail and/or Phone number to login

Solution Seeker Solution Provider

E-mail address or Mobile

☐ Remember me

OTP will be sent to registered mobile number & email address.

Login with OTP

Don't have an account? [Sign up](#)

- Chemical Industry,
- Industrial Associations,
- Govt. Regulatory Bodies,
- NGOs, etc.

- Innovators,
- Researchers
- Technology developers



The **G&SC Solution Providers Web Portal** was created to accelerate the adoption of green and sustainable chemistry solutions.



It is a free, open-access platform built to connect:

- › **Solution Providers:** innovators, researchers, technology developers
- › **Solution Seekers:** chemical industry players actively seeking safer, greener alternatives

The screenshot displays the 'Our Partners' section of the portal. It features a grid of partner logos and descriptions. The partners listed are UNIDO, the Center for Green Chemistry and Green Engineering at Yale, and Excel Industries Ltd. Below the partner logos, there are three main action buttons: 'Solution Provider Login & Upload', 'Solution Seeker Preview & Login', and 'Rate & Review Solutions'. Each button has a brief description of its function and a corresponding action link.

Home About us Categories Companies Contact us

Our Partners

UNIDO

CENTER for GREEN CHEMISTRY and GREEN ENGINEERING at YALE

EXCEL Excel Industries Ltd.

Solution Provider Login & Upload
Solution providers create an account to securely log in and upload their solutions to the platform.
[Start Uploading >](#)

Solution Seeker Preview & Login
Solution seekers browse glimpses of available solutions. To access full details, they must log in to their account.
[Browse Solutions >](#)

Rate & Review Solutions
Logged-in seekers can rate and provide feedback on solutions, helping to improve quality and trust.
[Join Reviews >](#)

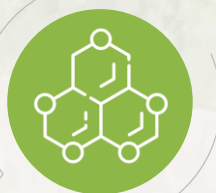
By bridging this gap, the portal makes credible innovations **more discoverable, scalable, and implementable.**

*It's not just a website, it's a **shared space for collaboration.***

Find your solutions in different categories

Green Catalysts

Inherently safe, less toxic,
abundantly available,...



Green Products

Chemical Products which are
inherently safer, non-toxic an...



Green Solvents

Greener alternatives to
conventional toxic & hazardo...



Green Informatics & Software

Information technology
(IT)/software based solutions..



Green Processes

Greener alternative processes for
conventional hazardous &..



Industry Ecology

Global solution providers offering a
platform where the...



Green Engineering

"Green Engineering" solutions
or technologies which include..



End-of-Pipe treatment

Global solution providers offering
solutions for end-of-...



Built for Solution Seekers. Designed for Solution Providers



Solution Seekers

(e.g., chemical industry players, manufacturers, brand owners, etc.)

- › **Discover ready-to-implement innovations** in green and sustainable chemistry
- › **Explore by need** - process, product, or performance goal
- › **Connect with solution providers** for pilots, partnerships, or scale-ups
- › **Stay ahead of regulations** and sustainability commitments



Solution Providers

(e.g., researchers, startups, technology developers, academic labs)

- › **Showcase your innovations** to a relevant, global audience
- › **Gain visibility** among industry stakeholders actively seeking solutions
- › **Invite collaboration** for trials, funding, or joint development
- › **Be part of a global knowledge ecosystem** advancing green chemistry



Let's Build This Together



Upload Your Solutions

Help us build a robust, diverse library of innovations.



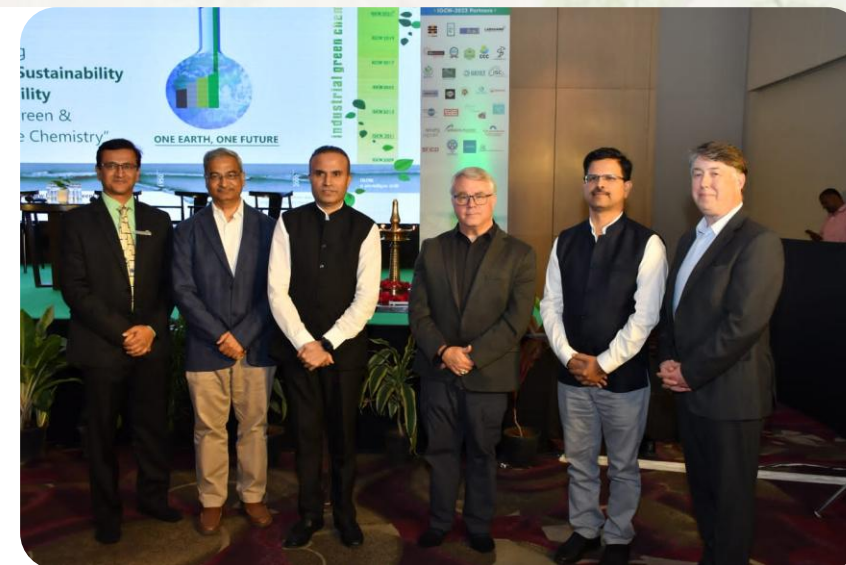
Explore What's Out There

Find solutions that fit your sustainability and performance goals.



Partner With Us

Join us in growing a community committed to safer, greener chemistry.



CONTACT US



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Mrs. Krishna B. Padia



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9136866174

The portal is open, the momentum is growing and we'd love you to be a part of it.

COLLABORATE. CONTRIBUTE. CREATE IMPACT.



Visit: <https://industrialgreenchemsolutions.org>