



Vapourtec UV-150 Photochemical Reactor

UV-150 Photochemical Reactor

‘Bringing photochemistry to the bench’

- **Photochemistry** has a number of important applications in **nature** and **industry**.
- Traditional **batch** photochemistry is **not popular**.
- Problems limit its use:
 - **Safety**
 - Availability and complexity of **equipment**
 - Control of reaction **conditions**
 - Difficulty in **scale-up**.



UV-150 Photochemical Reactor

‘Bringing photochemistry to the bench’

- The breakthrough Vapourtec **UV-150 photochemical** reactor makes photochemistry **accessible**.
- Allows the full **potential** of photochemistry to be exploited.
- Offers **safe, precise, efficient, consistent** and **scalable** photochemistry.

UV-150 Photochemical Reactor

Unique Selling Points

- Versatility
 - 3 different light sources provide precise wavelengths between 220 nm and 650 nm.
 - Reactor temperature range from -20°C to 80°C.
- Safety
 - All light sources are fully interlocked.
 - Can be used in standard fume cabinet, no additional light shielding required.
 - Forced ventilation prevents build-up of flammable gases or vapours.
- Precision
 - Filters in addition to optional light sources ensure precision control of wavelength.
 - Precision temperature control of the reactor.
 - Inert gas blanketing of the reactor.

UV-150 Photochemical Reactor

Key features



- Compatible with **R-Series** and **E-Series**.
- **3 light** sources available.
- **Interchangeable** light sources – all fit in **same reactor** body.
- Temperature control.
- Multiple **gram/hour scale-up**.
- Easily **changed** reactors.
- **Compact**, space saving design.
- Optional **spectrometer** for **real time** transmission spectra.
- Interlocks for **safety**.

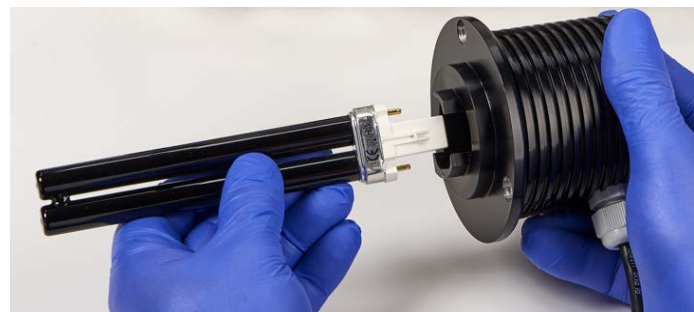
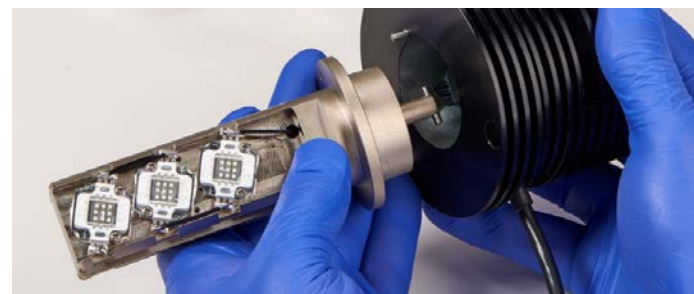
UV-150 Photochemical Reactor

Light sources



3 light sources available:

- **Medium pressure mercury lamp**
- **Monochromatic LEDs**
- **Low pressure mercury lamp.**





Medium pressure mercury lamp

UV-150 Photochemical Reactor

Medium pressure mercury lamp

- High intensity medium pressure mercury lamp.
- Manufactured specifically for Vapourtec.
- User selectable UV power.
- Wavelength filtering.
- Temperature control -5°C to 80°C .
- Maintained under cooled air conditions.
- Allows dimmable operation without compromising lamp life or spectral output.



UV-150 Photochemical Reactor

Selectable UV power

- **Selectable** power between **75 W** to **150 W**.
- Power supplied by a state-of-the-art electronic ballast.
- **Constant** and **precise** output.
- Output continuously **monitored** and can be **logged** using Flow Commander™ (R-Series).
- **Maximises** lamp life.
- Lamp life-end **automatically** detected.
- Fault conditions detected with **automatic** system **shut down** for **safety**.



UV-150 Photochemical Reactor

Temperature control

- Temperature control between **-5°C to 80°C**.
- **±1°C** resolution.
- Cooling provided by Vapourtec **cooled gas generator**.
- **Existing** cooled gas generators (purchased with cooled tube reactor) can be used.
- Temperature measured at **reactor wall** for most **accurate** temperature representation.

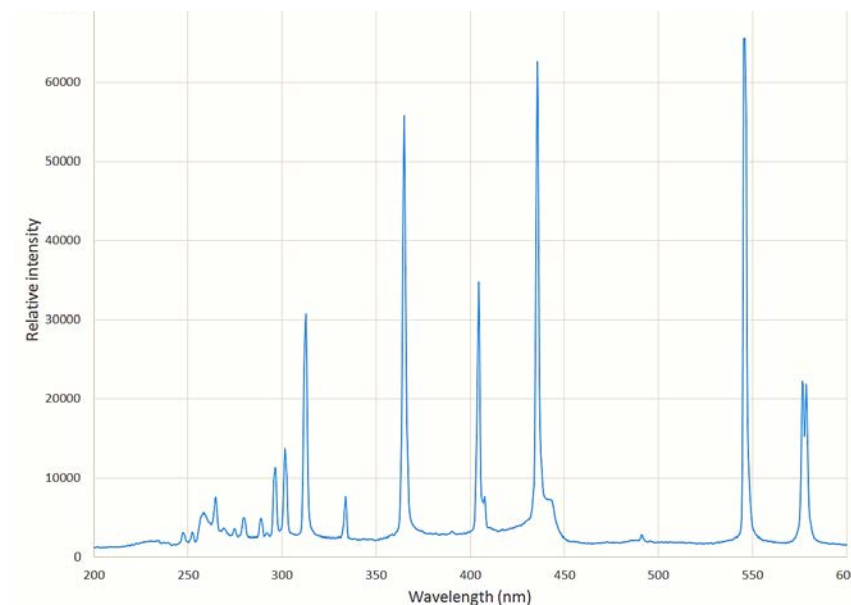


N.B. Cooled gas generator must be purchased with medium pressure mercury lamp.

UV-150 Photochemical Reactor

Wavelength filtering

- Medium pressure mercury lamp has a **broad radiant output**.
- Wavelengths from **220 nm** to **600 nm**.
- Wavelength **filters** allow **selection** of only desired wavelengths to promote intended reaction.
- Eliminates unwanted wavelengths that cause **side reactions** or **decomposition** of products.
- Removes **heating** effect of mercury lamp.



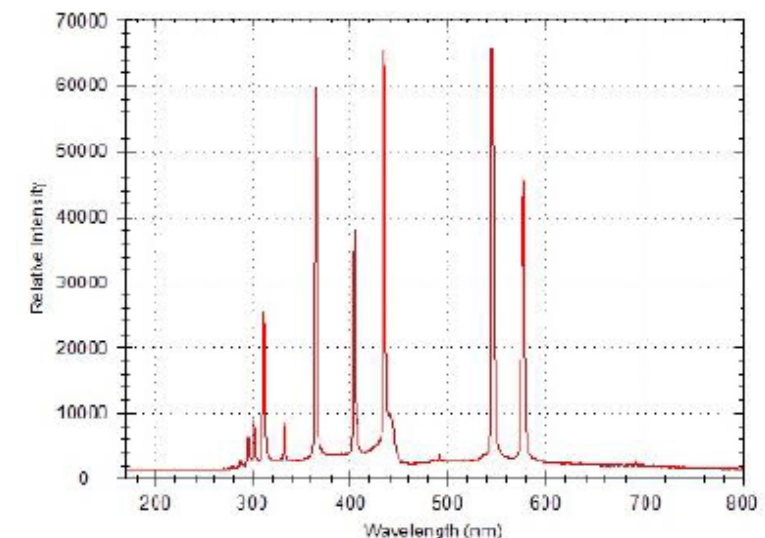
UV-150 Photochemical Reactor

Wavelength filtering

- Vapourtec offers **9** wavelength **filters**.
- **Long-pass** and **band-pass** filters available.
- Filters are positioned between the lamp and reactor.
- **Quickly** and **easily** changed by hand.
- Medium pressure mercury lamp should not be used **without** a filter.
- Filters reduce lamp **heating** effect by **40%**.
- Filter allowing full **spectral output** is available.



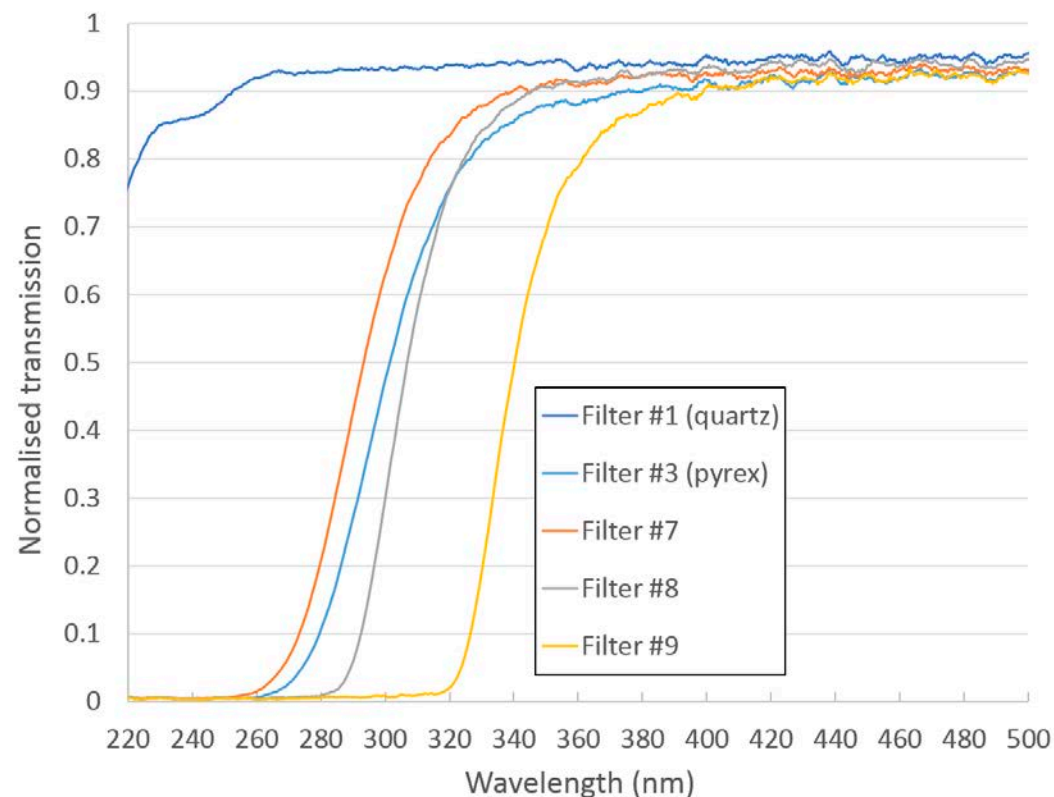
Transmission Spectra Type 3 Filter - Red



UV-150 Photochemical Reactor

Wavelength filtering – long-pass filters

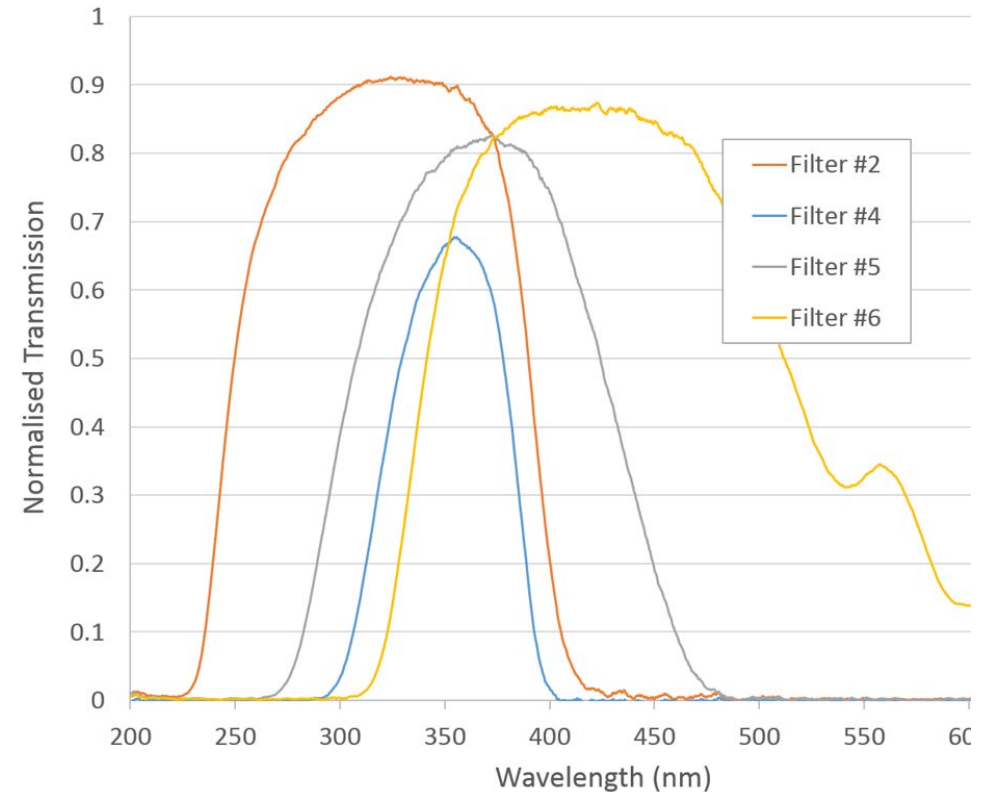
- Improve reaction selectivity by **eliminating shorter** wavelengths and **transmitting longer** wavelengths.
- **5 long-pass** filters available.
- Commonly **Pyrex** or **quartz**.
- Different materials have differing **refractive indices** allowing accurate wavelength filtering.



UV-150 Photochemical Reactor

Wavelength filtering – band-pass filters

- **4 band-pass** filters available.
- Transmit only a **specific wavelength** band.
- Eliminates both **longer** and **shorter** wavelengths.
- Eliminates most of the **heating effect** of the lamp.
- Allows **lower temperatures** to be used even with a medium pressure mercury lamp.

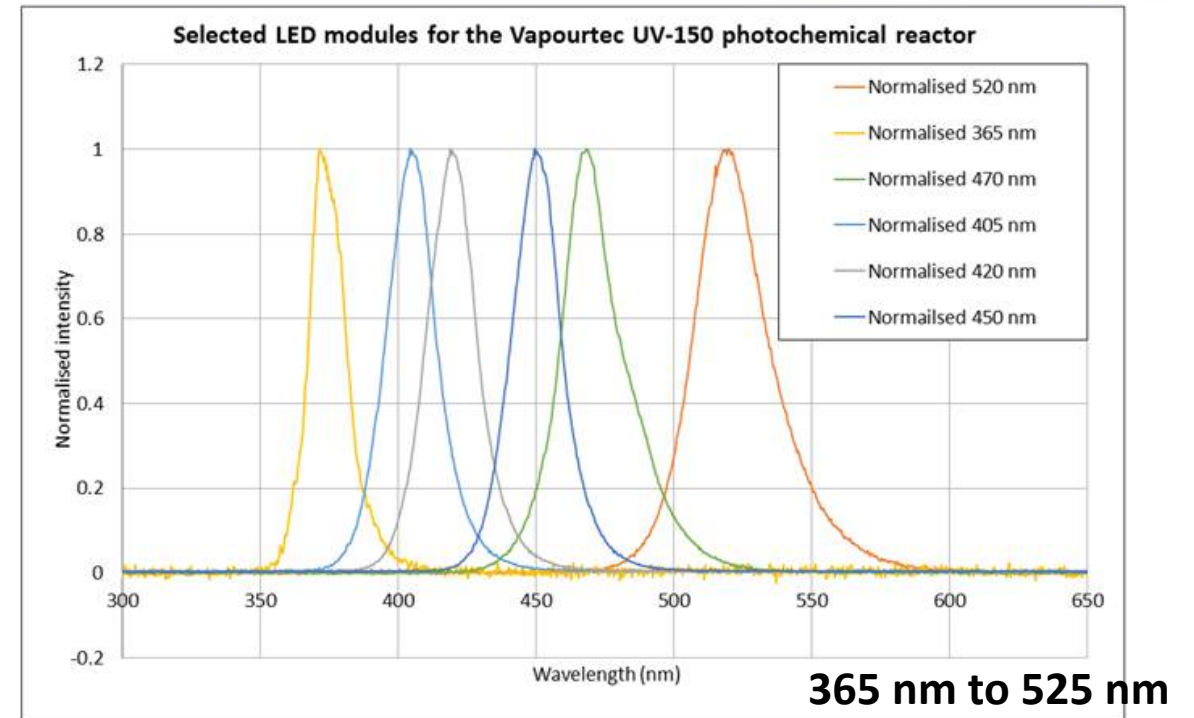




Monochromatic LEDs

UV-150 Photochemical Reactor LEDs

- **14 specific LEDs** available.
- Offer **precise** wavelengths.
- No need to **filter**.
- Range from **365 nm** to **525 nm**.
- **-40°C** to **80°C** temperature range.
- Interchangeable.
- **Efficient**.
- Lifetime of approx. **10,000 hours**



UV-150 Photochemical Reactor

LEDs

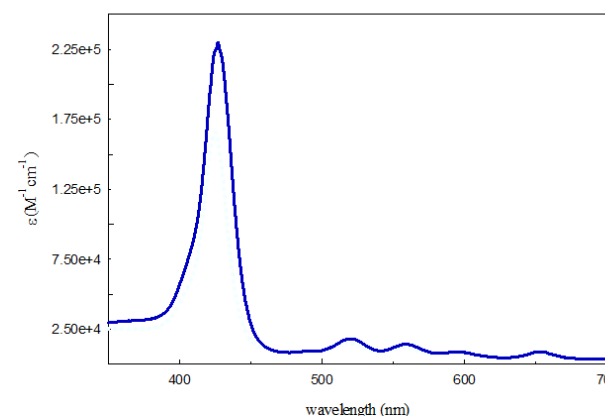
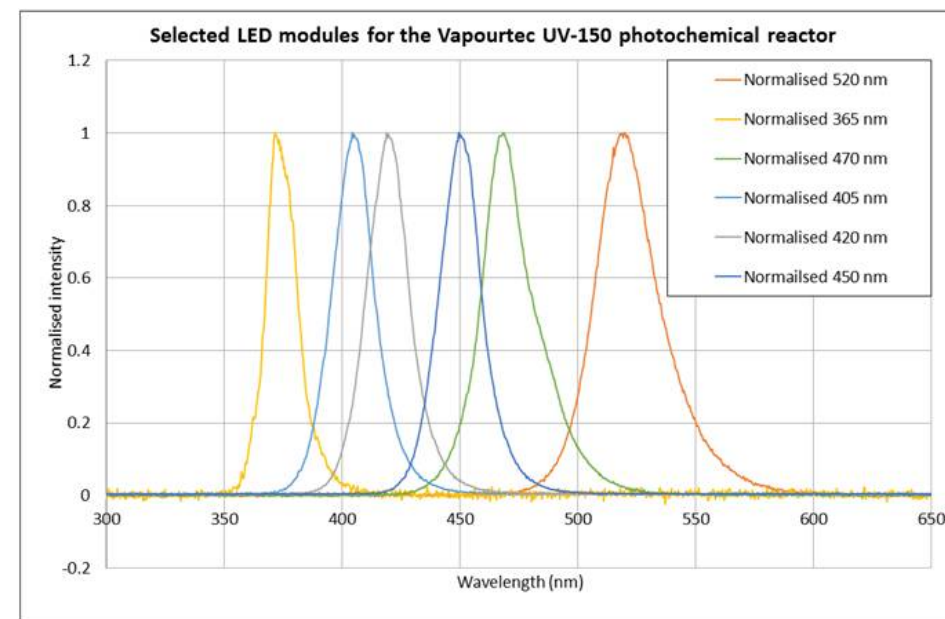
Wavelength (nm)	LED type	Input power (Watts)	Radiant Power (Watts)	Approximate efficiency (%)
365 nm	Gen-1	60W	3W	5%
365 nm	Gen-2	62W	16W	26%
385 nm	Gen-1	60W	4.2W	7%
385 nm	Gen-2	60W	18W	31%
395 nm	Gen-1	60W	6W	10%
405 nm	Gen-1	60W	9W	15%
410 nm	Gen-1	60W	12W	20%
420 nm	Gen-1	60W	18W	30%
430 nm	Gen-1	60W	24W	40%
440 nm	Gen-1	60W	24W	40%
450 nm	Gen-1	60W	24W	40%
470 nm	Gen-1	60W	24W	40%
495 nm	Gen-1	60W	8.8W	22%
525 nm	Gen-1	60W	3W	5%

Available LEDs with the UV-150 photochemical reactor

UV-150 Photochemical Reactor

LEDs

- For **photocatalytic** reactions, **LEDs** are the ideal choice.
- Can choose an LED with a dominant **wavelength** to **match** the absorption of your **photocatalyst**.
- Maximises **throughput** and minimises **side reactions**.



Absorption spectra of the common photocatalyst TPP.

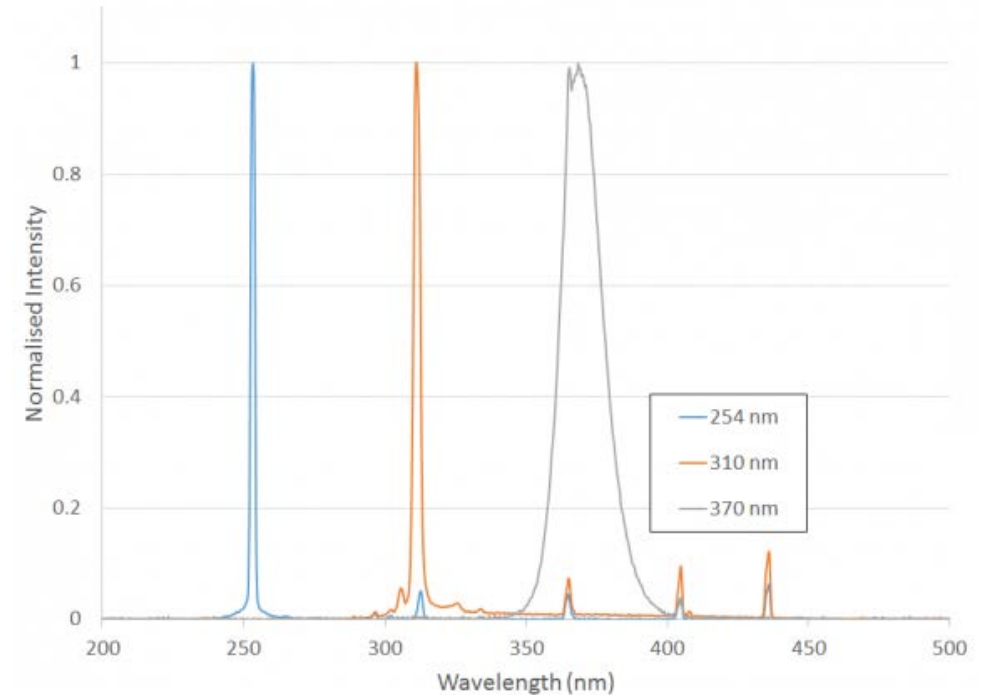
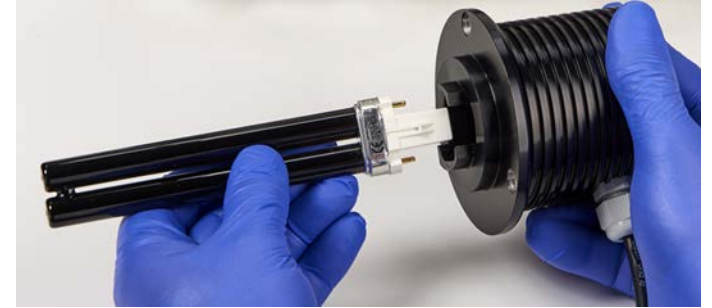


Low pressure mercury lamp

UV-150 Photochemical Reactor

Low pressure mercury lamps

- **3 lamps** available.
- **Specific** wavelength emission; **254 nm, 310 nm** and **370 nm**.
- Provides wavelengths **not achieved** by medium pressure mercury or LEDs.
- Do not require **filters**.
- **Low heat load**.
- **-40°C to 80°C** temperature range.
- **Efficient**.





UV-150 Key features

UV-150 Photochemical Reactor

Safe and accurate heat management

- Reactor and lamp are housed in **separate, sealed quartz** chambers.
- Air is **circulated** within each chamber to **cool** the lamp/ reactor and to **dissipate** heat.
- Warmed air from each chamber is then **separately exhausted** from the system.
- **High flow rate** of gas allows effective temperature control.
- **Dichroic mirror** also removes heat from the system.
- Mirror ensure more than **90%** of UV energy is **reflected** back into the reactor.



UV-150 Photochemical Reactor

Interlocks for safety

- **Safety** is **fundamental** in the UV-150 design.
- Can be safely used in a standard laboratory fume cabinet.
- Light sources are completely **enclosed**.
- Power supply is **interlocked**.
- Power is **safely** and **automatically disconnected** if lamp becomes exposed.



UV-150 Photochemical Reactor

Easily changed reactors

- Reactors are made from a **single** layer of **thin** walled, small bore **fluoropolymer** tubing.
- Maximises photon **absorption**.
- Constructed in **cartridges**.
- Can be changed in **seconds**.
- Cartridges available in a range of volumes; **2 ml**, **5 ml** and **10 ml**.
- Smaller reactors **reduce** reagent **consumption** when optimising conditions.
- User **rewindable** cartridges available (10 ml).



UV-150 Photochemical Reactor Compact design

- The UV-150 is much **smaller** than traditional photochemical reactors.
- Additionally no external **recirculating chiller** is required.
- Occupies only **one** (E-Series) or **two** (R-Series) reactor positions.
- Allows **telescoped** photochemical reactions.



E-Series



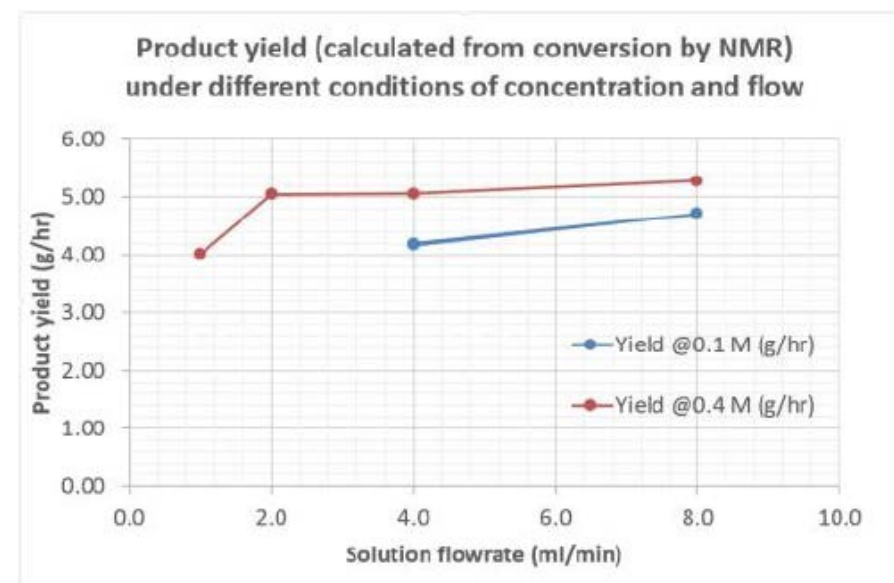
R-Series

UV-150 Photochemical Reactor

Multiple gram/hour scale-up

- Scale-up of traditional **batch** photochemistry is **challenging**.
- The **high power** of the medium pressure mercury lamp means UV-150 photochemistry is easily **scalable**.
- Can synthesis **multiple gram/hour** quantities.
- The [2+2] cycloaddition of Maleimide and 1-Hexyne (replicated from literature) achieved **>5 g/hour** conversions.

[2+2] Cycloaddition of Maleimide and 1-Hexyne



UV-150 Photochemical Reactor

Real time spectral data

- **Real time** spectral information is a huge benefit in photochemical reactions.
- An optional spectrometer allows spectral **intensity, wavelengths** and reactant **absorption** to be measured.
- A fibre-optic **probe** conveys light to the spectrometer.
- Position enables the probe to '**look through**' the reactor **directly** towards the lamp.
- Allows the relative **spectral intensity** to be measured as the reaction occurs.



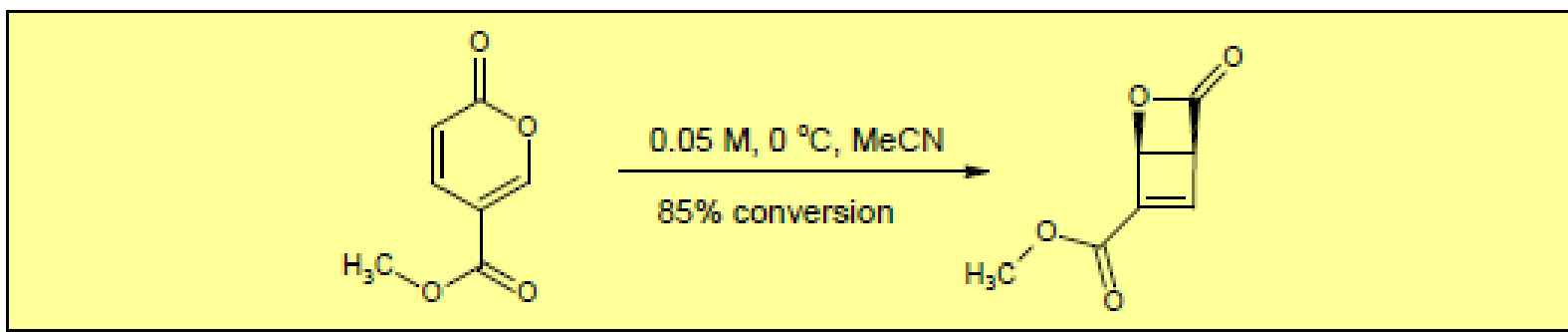


Applications

Applications – Medium pressure mercury lamp

Photochemical Transformation of methyl coumalate.

- The photochemical transformation of **methyl coumalate** via **4π electrocyclication** is well characterised.
- Medium pressure mercury lamp.
- Filtering to remove wavelengths **below 295 nm** to prevent unwanted side reactions.

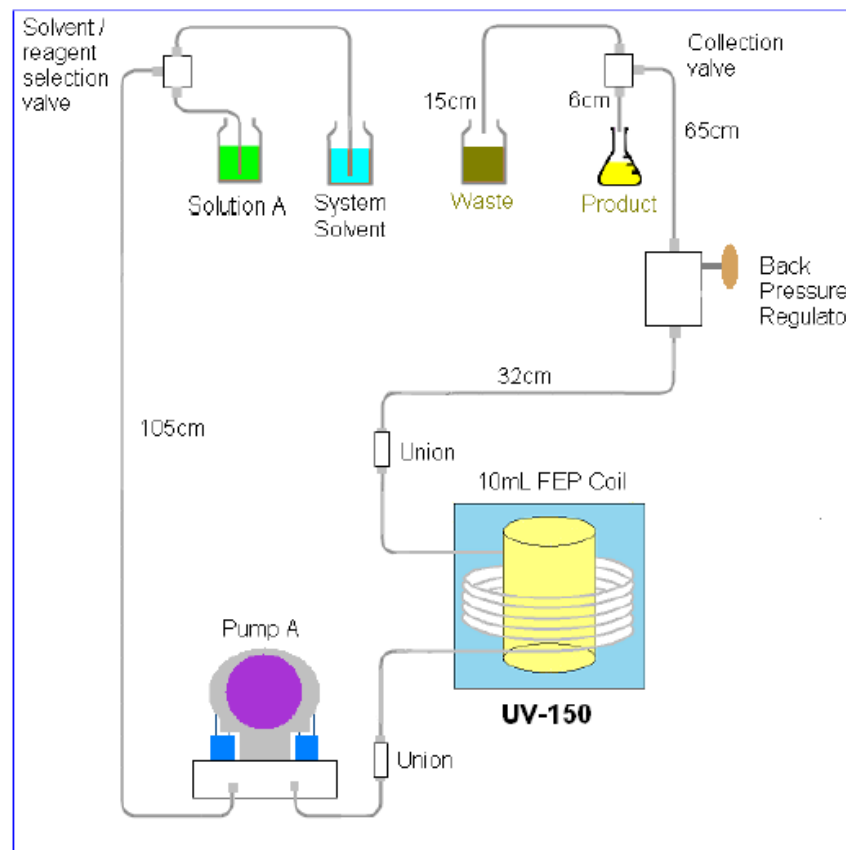


The photochemical transformation of methyl coumalate to the pyrone via 4π electrocyclication.

Applications – Medium pressure mercury lamp

Photochemical Transformation of methyl coumalate.

- Vapourtec UV-150 photochemical reactor with **medium pressure mercury** lamp and wavelength **filter 3**.
- Allows **safe** and **efficient** continuous photochemistry.
- 8 fold **decrease** in reaction **time**.
- 8 fold **decrease** in solvent **use**.

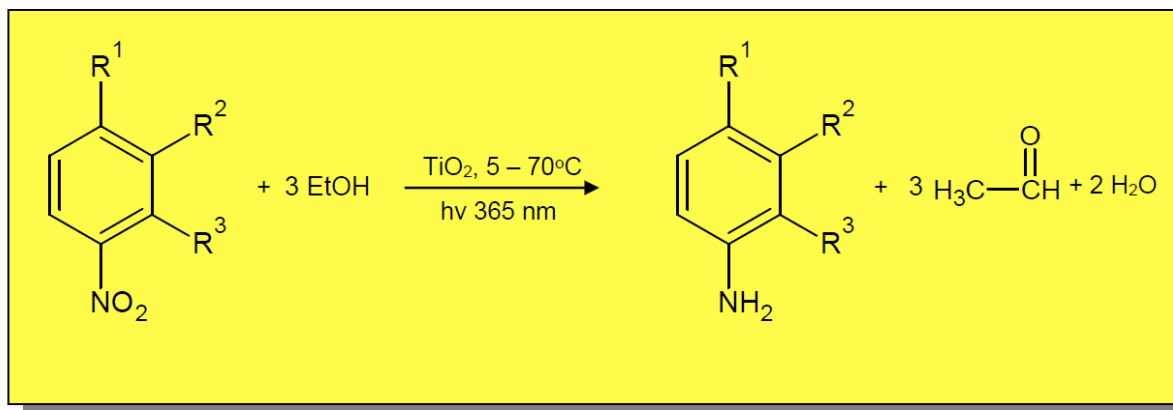


**E-Series configuration
of the continuous
photochemical
transformation of
methyl coumalate.**

Applications – LEDs

Photochemical hydrogenations of nitro compounds.

- Photochemical reductions of **nitro compounds** are important photochemical reactions.
- Nitro compounds are reduced to their corresponding **aniline**.
- Aniline compounds are **synthetically** important.
- Key **building blocks** in many synthetic steps.

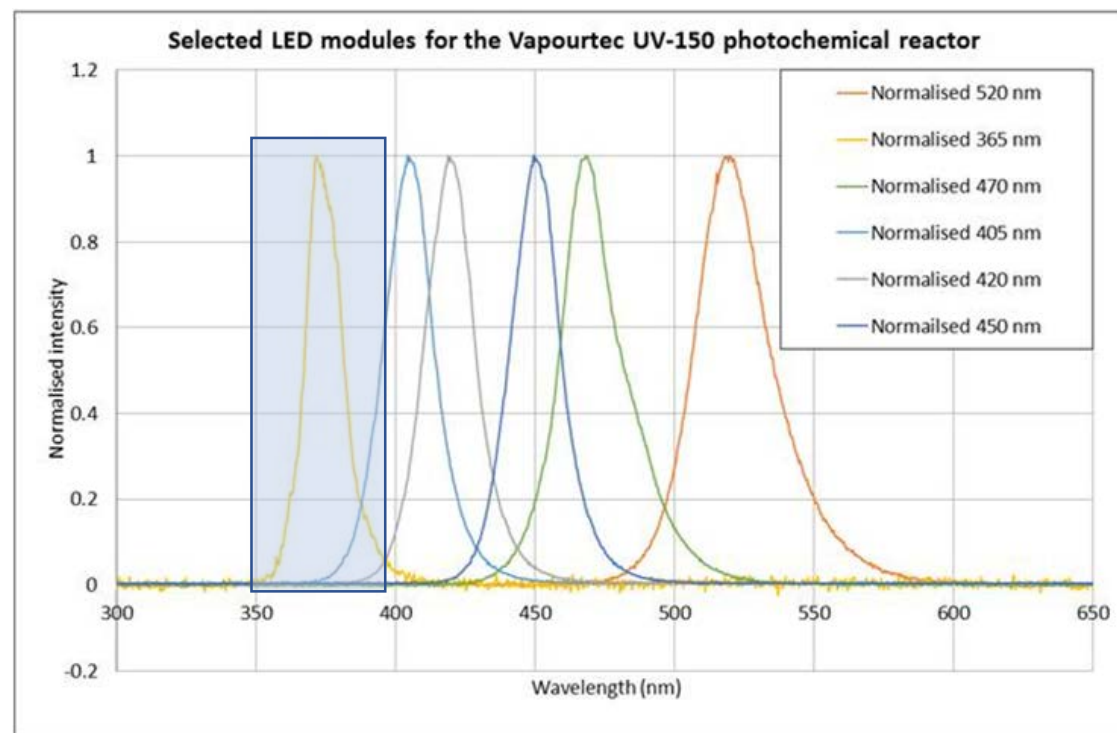


The photocatalysed reductions of nitro compounds to their corresponding aniline.

Applications – LEDs

Photochemical hydrogenations of nitro compounds.

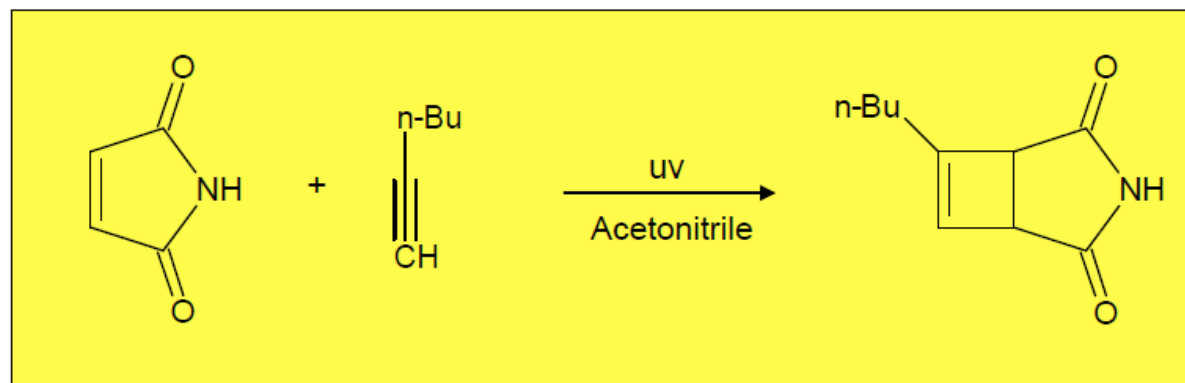
- Vapourtec UV-150 photochemical reactor with **generation 2 LED (Gen-2)** light source.
- Accurate and uniform **365 nm** irradiation.
- Gives impressive **throughput** comparable to mercury light sources.
- Greater **efficiency** and **precision**.



Applications – Low pressure mercury lamp

[2 + 2] photocycloaddition of maleimide and 1-hexyne.

- The [2 + 2] photocycloaddition of **maleimide** and **1-hexyne** is well established.
- Precise irradiation **time, temperature** control and **wavelength** filtering are **crucial**.
- Difficult to achieve in **batch** conditions.
- Vapourtec UV-150 photochemical reactor allows **precise** control.



The photocycloaddition of maleimide and 1-hexyne.

Applications – Low pressure mercury lamp

[2 + 2] photocycloaddition of maleimide and 1-hexyne.

- Low pressure mercury lamp gives **specific** and **narrow** wavelength emission.
- Match the **specificity** of LEDs but offer wavelengths **below 365 nm** and **higher** radiant power.
- Little **heat** generation compared to medium pressure mercury lamp.

