Case study

# Shaking Incubator Energy Consumption

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Shaking incubators agitate culture media, ensuring aeration and an even distribution of nutrients. They are used to grow yeast, bacterial cultures and tissue cultures, shaking incubators are found a wide range of research laboratories. Units are in regular use and may be shared by a number of researchers with many samples required to be heated and agitated for 24 hours. Ranging in size, units may be benchtop or large, stackable floor standing models (*Figure 1*).

## Testing the Large Shakers


*Figure 1. Three stacked shaking incubators.*

Four different models of floor standing units were tested, this testing was sponsored jointly by Eppendorf UK and Scientific Laboratory Supplies Ltd. Although the tested units are considered as large they were of varying capacity and platform size. To capture a standardised energy consumption each unit had its platform covered with sticky mats (*Figure 2*). Firstly, the time and energy used to heat up the empty chamber to 37°C was measured. Following this each unit was then filled with the maximum number of 2L Erlenmeyer flasks, each flask containing 1L of water (*Figures 3* and *4* show the lowest and highest number of flasks accommodated respectively). Filled with the maximum number of flasks, each unit was set to 37°C and shook the flasks at 200RPM. The average ambient temperature each shaking incubator was operating under was also recorded (*Table 1*).

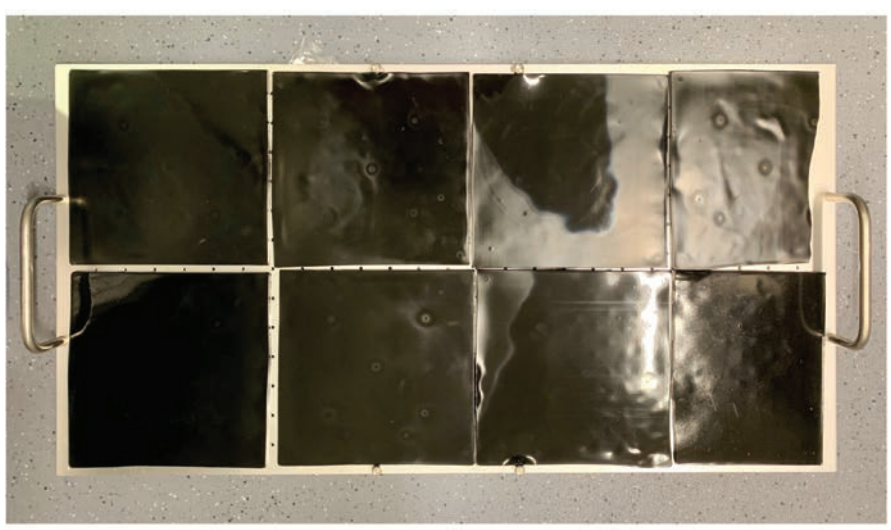

*Figure 2. The platform of the Kuhner shaker covered in sticky mats.*

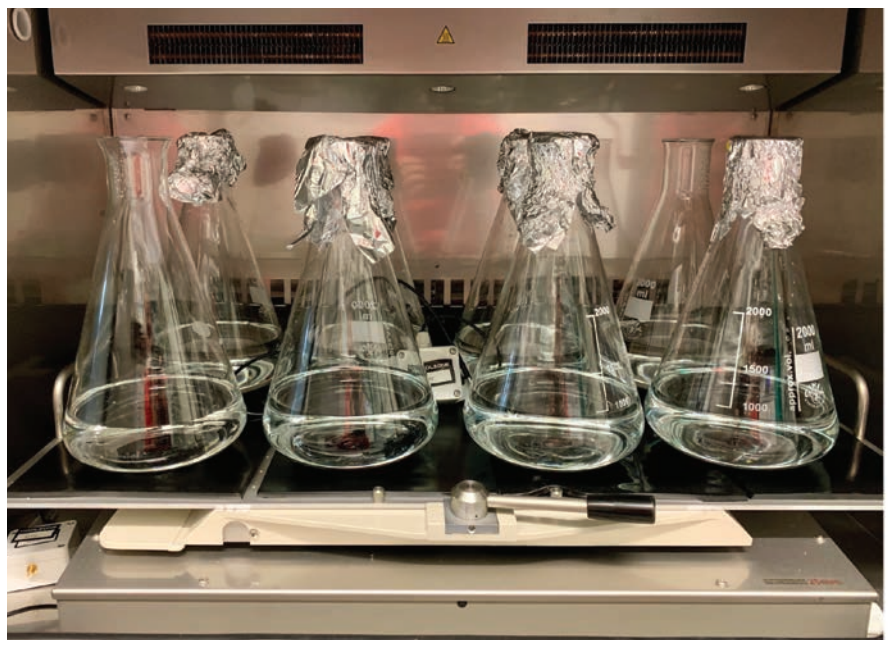

*Figure 3. The Kuhner unit filled with 8 Erlenmeyer flasks.*


*Figure 4. The Eppendorf S44i filled with 15 Erlenmeyer flasks.*

*Table 1. Running cost data. Units shaking at 200RPM.*

| Manufacturer | Kuhner | Eppendorf/New Brunswick | Infors | Eppendorf |
|---|---|---|---|---|
| Model | ISF1-X | Innova 44 | Multitron Standard | S44i |
| Test Site | Francis Crick Institute | Francis Crick Institute | M.R.C - L.M.B. | Kings College London |
| Platform Dimensions ($m^2$) | 800mm x 420mm (0.336$m^2$) | 760mm x 460mm (0.350$m^2$) | 850mm x 470mm (0.399$m^2$) | 762mm x 620mm (0.472$m^2$) |
| Maximum Loading Capacity | 25kg | 16.9kg | 19kg | 35.4kg |
| Average Ambient Temperature | 22C | 22C | 21C | 19C |
| Heat Up Time to 37C | 11 Minutes | 33 Minutes | 20 Minutes | 12 Minutes |
| Energy to Heat Up To 37C (kWh) | 0.160 | 0.230 | 0.155 | 0.130 |
| Energy to Heat at 37C Empty (kWh/Hr) | 0.158 | 0.220 | 0.148 | 0.230 |
| Maximun 2L Erlenmeyer Flasks Per Platform | **8** | **12** | **14** | **15** |
| Energy to Heat & Shake Max. Flasks kWh /Hr | 0.206 | 0.290 | 0.330 | 0.320 |
| Energy to Heat & Shake Max. Flasks kWh /Hr/Flask | **0.026** | **0.024** | **0.024** | **0.021** |

## Discussion

From the data shown in Table 1, the energy consumptions per 2L Erlenmeyer flask were very similar with the S44i having the lowest energy consumption of the 4 units tested. The Kuhner unit was the fastest in heating up to 37°C with the S44i being 1 minute behind. The S44i used the lowest amount of energy to heat up to 37°C. The differences in ambient temperatures would have had an effect upon the energy consumption and heat up times, with the units in the colder conditions likely to be at a disadvantage. Also, the different loading capacities may also be explored further to identify the impact of shaking the maximum loading capacity. The weight of a 2L Erlenmeyer flask containing 1 L of water is approximately 1.381 kg. In the case of the Innova 44 this total weight equates to 16.572 kg, very close to its maximum loading capacity, whilst in the case of the S44i the maximum number of flasks still results in >40% of the weight bearing capacity being unused. It must also be noted that the 2L Erlenmeyer flasks would not commonly be filled to 1L. Routinely the flask would be filled to 25% of its capacity to ensure optimal oxygen transfer to the culture media, such volumes could also be measured in the future study.

What has been highlighted is that the energy consumption of these units when shaking and heating is similar to that of a ULT Freezer per hour. An Eppendorf F570h Cryocube at the -80°C set point consumes 0.317 kWh/hour; both the Infors Multitron and Eppendorf S44i use just over this amount when shaking and heating. Therefore, when considering good lab practice it is advisable to ensure that units are not left on by accident.

Furthermore, to save energy units should be fully loaded whenever possible as it would be wasteful to use considerable energy to heat and shake a single flask or container.

## Aknowledgements

Special thanks to all those who made this study possible in particular:

Dr Matt Williams, Quadrant Laboratory Operations Manager, The Francis Crick Institute.

Ms Rajnika Hirani, Head of Sustainability and Business, The Francis Crick Institute.

Mr David Pledge, Laboratory Services and Purchasing, MRC Laboratory of Molecular Biology.

Ms Joana Furtado, UK DRI Technician, Institute of Psychiatry, Kings College London.

Mr Martin Farley, Health School Sustainability Manager, Kings College London.

Mr Joshua Chapman, Marketing Director, Scientific Laboratory Supplies Ltd

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