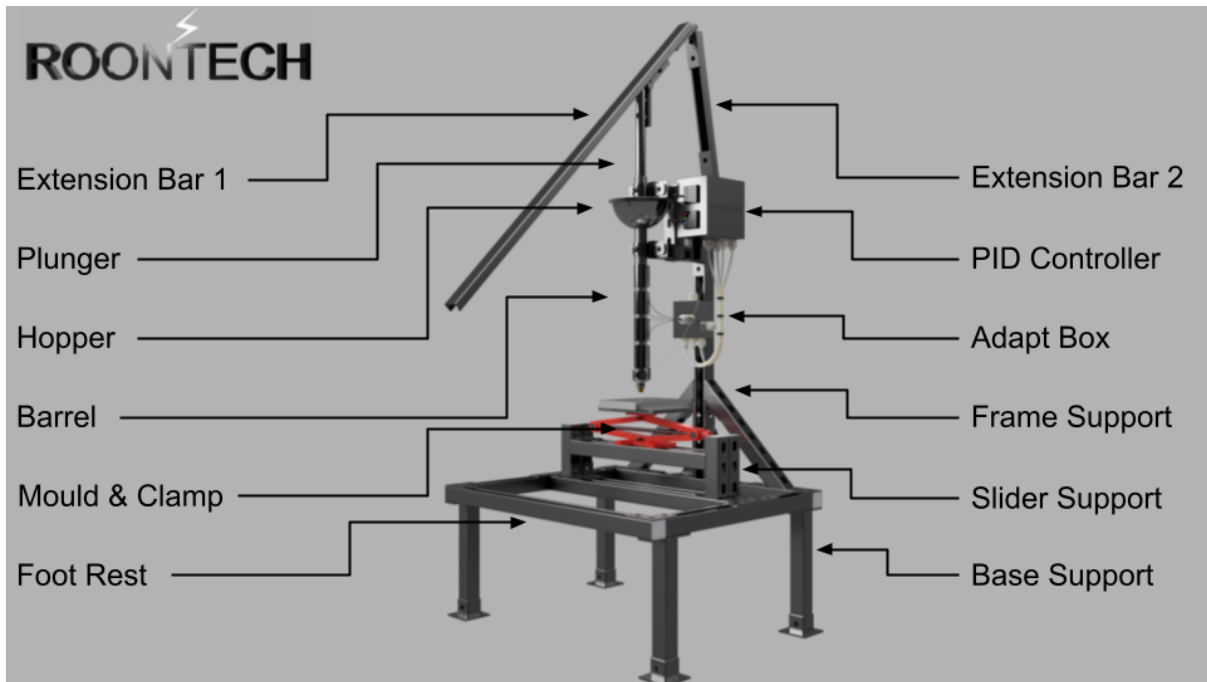# Injection Mould Machine

Fig 1, Injection Mould Machine Concept

After a little research I have designed an IMM, it is manual and it should produce a reasonable amount of force. The good thing about a manual IMM is that you do not require high pressure, the bad thing is that units take a bit longer to produce.

ROONTECH IMM Components

Table 1, IMM Components List

Component	Specification	Quantity	Cost
Band Heaters	200 Watt	4	£35
500mm Steel Tube (CDS)	O/D = 33.34mm Wall = 3.25mm	1	£13.50
700mm Steel Bar	D = 26mm	1	£25
Car Jack	1 Tonne	1	£7
Extrude Nozzle A	1" to ½ 2 (BSPT)	1	£5
Extrude Nozzle B	½" to 10mm	1	£2
PID	0 - 400℃	2	£20
SSR	2-24v	2	£10

Thermocouple	K-Type	2	£4
Control Switch	220v	2	£5
Power Cord/Plug	220v, 2.5mm, (HR)	1	£5
PID Housing	200 x 200 x 100	1	£12
BH Cable Housing	100 x 100 x 50	1	£5
Stuffing Glands	20mm (White)	10	£7
Hopper Dish	150mm	1	£2
Unistrut (HG)	3M, (Slotted)	3	£120
Unistrut (LG)	3M, (Solid)	1	£30
L Plate	Flat	4	£8
L Plate	90°	14	£40
T Plate	Flat	4	£8
T Plate	90°	2	£8
Gusset	Frame Support	1	£30
Angled Plate	45°	4	£8
Hinge Bracket	Flat	3	£30
Tube Brackets	34mm	2	£10
Support Leg	Frame Support	4	£25
Base Plate	Frame Support	4	£15
Bolts	M8	100	£10
Zebedees	M8	100	£40
Washers	M8	100	£5
Earth Clamp	K-Type Clamp	1	£1
End Caps	HG White Plastic	10	£2.50
			Total £550

Frame Support Dimensions

Note; Built to my height and assembled from the first listed component to the last. All components are metal, exposed conductive components are bonded to the CPC.

Table 2, Frame support Dimensions

Component	Specification	Quantity	Dimension (mm)
Unistrut Frame	Heavy Gauge	2	760 (L)
Unistrut Frame	Heavy Gauge	2	580 (W)
Upright Frame	Heavy Gauge	1	800 (H)
Frame Support	Heavy Gauge	4	300
Angled Strut	Heavy Gauge	1	370
Wall Support	Heavy Gauge	1	445
Extension Support	Heavy Gauge	2	200
Extension Support	Heavy Gauge	1	115
Extension Bar 1	Shallow Gauge	1	420
Extension Bar 2	Shallow Gauge	1	1100

Specification

Table 3, IMM Specification

Height (mm)	V	Power (Kw)	bar/psi	Capacity (g)	Temp ℃	Clamp
1500 - 2235	230	0.8 - 1	45/650	120	185-200	1, t Jack

Operation

1. Turn on IMM
2. Set desired temperature
3. Leave for 15 minutes
4. Raise extension bar
5. Add HDPE to hopper
6. Wait 10 Minutes to melt
7. Place Mould on platform
8. Slide into position
9. Clamp the Mould
10. Pull extension bar down
11. Inject Mould until HDPE is visible

12. Hold extension bar for 20 seconds
13. Raise extension bar
14. Add HDPE to the hopper
15. Slide the Mould away
16. Open Mould and remove part
17. Close Mould
18. Repeat steps 7-17

Note; The extension bar should always be at the lowest point before turning on, this ensures it heats up correctly, so the barrel and bar are of equal temperature, this helps reduce friction that results in scorch marks of the part. The Chamber/Barrel can hold 3 x the initial shot volume, so when you inject and replace the HDPE you still have 2 x the volume shot up to temperature ready to inject. It is very important to refill the barrell after every injection as test runs show that burn marks will appear if you run it near empty due to friction between the Bar, Chamber and HDPE, at any temperature. Speed is a crucial factor in successful operation, low speed runs of approximately 10 minutes per injection can be performed at 140℃, injection speeds of approximately 6 minute requires a higher temperature of 185 - 200℃. Also the extension bar on completion of injection should finish at a 90° angle. Eddie Hall, (WSM 2017) determines positioning and technique delivers maximum applied force.

Rex C100 PID Commissioning

Proportional–Integral–Derivative Controller (PID), this is the brains of the operation, the device that maintains the temperature. It comes pre-programmed and has many functions for numerous control types. There are three settings to change regarding the IMM, the first is the (AR) setting. This setting controls the power delivered from 1-100%. Trial and era suggests that 10% solves for overshoot which is where the temperature goes far beyond the temperature selected over heating the HDPE and burns it. The PID then operates via a pulsing technique, gradually working its way up to temperature, when it hits the temperature an alarm signals the power to be cut. The alarm is the second setting to change and is set to $\pm 1℃$**.**

The third setting is Auto Tuning, the tuning algorithm aims to balance performance and robustness while achieving the control bandwidth and phase margin that you specify. With these three settings configured and locked in, absolute control of the temperature is maintained. The PID generally steps up the wattage from turning on the machine from 350, 480, 650, 780 and finally 900 watt. When the machine is up to temperature the PID sends a signal to the Solid State Relay (SSR) that energises the Band Heaters for 2 seconds, every 10 seconds. This technique is highly efficient regarding energy consumed. It approximately works out to use 5p per Kilowatt Hour, 8-hour day, over 5 days costs £2. Using 2 x PID's, 1 operates the Band Heaters via a Thermocouple (K-Type) attached to the Barrel, the second PID monitors ambient temperature and is also used to check the Band Heaters are working correctly.