**Implementation of advance equipment in Ayurveda pharmaceutics wsr to bhasma.**

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 **Introduction**

 About 8th to 9th century A.D.(period of Nagarjuna), a beginning of Rasashastra , many new pharmaceutical processing techniques ,equipments and drugs were evolved and developed which have revolutionized in Ayurvedic Pharmaceutical technology to such an extent that by using different metals could be converted to most suitable for their internal use.

 Due to their miraculous efficacy, mercurial preparations like Kupi Pakva and Pottali rasayana are mainly used as an emergency drug. On the other hand, for Rejuvenation and disease cure, gave rise to the non-mercurial preparations like Ayaskrti, Pisti, Bhasma etc. But in the due course of time Bhasma Kalpana got popular day by day due to its unique assimilatory organo- metallic constitution. Bhasma is end product of purified metals and minerals is prepared with Specific quantum of heat is given according to nature of drug and converted to nano particles. This heating device is called as puta.

 The amount of heat to be given was defined in ancient texts by means of specific design arrangement of cowdung cakes on the surface of earth or in the pit (specially constructed for burning dried cowdung cakes).Various puta’s are described as Mahaputa, Gajaputa, Varaha puta, Kukkuta puta, lavaka puta, kapota puta,this gradation gives specific quantum of heat to the substances so that they become more finer & finer.

 Due to the technological development in the current scenario, electrical horizontal muffle furnace is used for the preparation of Bhasmas.

**Rationality behind use of Electric Muffle Furnace**

1. In ancient times, the acharyas prepared bhasma for their patients themselves. Today, few practitioners follow this practice. Nowadays due to increase demand of different bhasma in large scale productions, there is need of modern instruments in industries which has raised concerns about their Safety, efficacy of medicines as well as Indian heritage.
2. Due to the influence of the atmosphere and cowdung cakes ignition in classical putapaka; there will be vary in attaining the maximum temperature in different successive Putas. So, provision of less heat loss and homogenous temperature is possible in muffle furnace a modified instrument by which a desired highest temperature and duration of heat can be adjusted.
3. Necessity of Documentation of standardization of bhasma by maintenance of adequate heating and temperature pattern.
4. Electric Muffle Furnace found comfortable owing to various aspects like no labor, easy operation and well regulated apparatus.
5. Due to less availability of cowdung cakes in metropolitan cities it’s difficult to follow traditional medicine preparation. As there is easily available of electricity and related gadgets helps to prepare medicines in short period.

**METHOD OF PUTA –**

Generally in putapaka method, total number of Cow dung was taken. 2/3rd part of Pit was filled with maximum number of cowdung cakes (average), each Cow dung cakes in and average measures 140 gm weight, 13 cm in diameter, 4 cm thickness at Center, 2cm at periphery. Sharava Samputa which contains pellets of purified drugs was placed middle of the cakes. 1/3rd portion of pit was filled with remaining cowdungs. Fire ignited from the above. This procedure is repeated till drugs attain bhasma siddhi lakshana.

**ELECTRICAL HIGH TEMPERATURE VERTICAL MUFFLE FURNACE**

**Introduction:** Muffle furnace is a front-loading box-type oven or kiln used in many research facilities, to determine what proportion of a sample is non-combustible and non-volatile (i.e.ash) Incineration processes, drying, degradation, re-heating, thermal treatments etc. Furnaces are usually heated to desired temperatures by conduction, convection, or blackbody radiation from electrical resistance heating elements.

 **HORIZONTAL MUFFLE FURNACE:** Muffle Furnace is designed as rectangular chamber using light-weight material, provided with heating elements and temperature controller. The furnaces are designed in compliance with the industry standards.

**Parts -**

* Exterior chamber – Mild Steel Body,
* Interior chamber - Insulation Bricks, 4 sets of Kanthal A-1 heating coils covered with Good refractory muffle, Ceramic fibre blanket, and Ceramic rope.
* Control Panel – Main Switch, Main indicator lamp, Programmable digital electronic temperature and time controller, simultaneously indicating the actual and set temperature by K thermocouple. Heater on indicator, heater switch.

 Other – Crucible tongs, Thermal gloves

1. **Mild Steel Body** –

Steel is an [alloy](http://en.wikipedia.org/wiki/Alloy) that consists mostly of [iron](http://en.wikipedia.org/wiki/Iron) and has a [carbon](http://en.wikipedia.org/wiki/Carbon) content between 0.2% and 2.1% by weight, depending on the [grade](http://en.wikipedia.org/wiki/Steel_grade). Carbon and other elements act as a hardening agent, preventing [dislocations](http://en.wikipedia.org/wiki/Dislocation) in the iron atom [crystal lattice](http://en.wikipedia.org/wiki/Crystal_lattice) from sliding past one another and controls qualities such as the [hardness](http://en.wikipedia.org/wiki/Hardness_%28materials_science%29), [ductility](http://en.wikipedia.org/wiki/Ductility), and [tensile strength](http://en.wikipedia.org/wiki/Tensile_strength) of the resulting steel. Steel with increased carbon content can be made harder and stronger than iron.

1. **Insulation (Refractory) Bricks** –

Interior chamber constructed from high quality lightweight refractory (Insulation) bricks, with high alumina content with no asbestos or iron oxide. The bricks are obtained by a mix of **selected clays and expanded perlite,** processed in the plant-facilities according to the internal specifications.

 Features- Temperature range - 2000C – 1750 -
 - High mechanical strength
 - Structural and dimensional stability
 - Minimal creep in compression
 - Very light weight and Excellent Insulating properties

1. **Ceramic fibre blanket** - Are flexible, Hi-Alpha Alumina fiber insulation materials, mainly composed of Al2O3, SiO2, organics and other trace elements . Mainly used in heated furnace lining. These polycrystalline fiber blankets offer higher temperature capability, less shrinkage and greater chemical resistance.

 Features – Temperature range - 2000C - 16000C

 - High tensile strength

 - Low thermal conductivity

 - Low shrinkage

 - Excellent hot strength.

 - Low heat storage.

1. **Kanthal A-1 Coils –** Kanthal is an [alloy](http://en.wikipedia.org/wiki/Alloy) of mainly [iron](http://en.wikipedia.org/wiki/Iron), [chromium](http://en.wikipedia.org/wiki/Chromium) (20–30 %) and [aluminium](http://en.wikipedia.org/wiki/Aluminium) (4–7.5 %).The alloy is known for its ability to withstand high temperatures and having intermediate electric resistance. Kanthal wire forms a protective layer of aluminum oxide ([alumina](http://en.wikipedia.org/wiki/Alumina)) which required to make good electrical connections. Ordinary Kanthal has a melting point of 1,200 °C. Special grades have a melting point as high as 1,425 °C .
2. **Power Switch –** Turns main power on and off to furnace.
3. **Digital Display –** Displays the operating and programmed temperatures, Times and status condition.
4. **Power Light –** Illuminate when power is on.
5. **Set temperature –** The muffle temperature is regulated by adjusting the power controller to the required power level, necessary to achieve the desired temperature.
6. **Heater switch -** Turns the Kanthal A-1coils on and off to furnace. Serves as an ON/ OFF switch and a proportional electrical power controller. It controls the power applied to the coils and muffle temperature. When the desire temperature level raises it automatically switched off. When it comes down it automatically switched on.
7. **Heater Light -** Illuminate when Heater is on.
8. **Thermocouple –** Pyrometer consists of K-type inconel thermocouple or sensor K-type with inconel S/S sheath; compensating cable or extension wire.

**Temperature –** Displays the currently programmed temperature and gives the operator to access and programme the desired value. The temperature LED’S alternately flash each time when SET TEMP adjusted. When the corresponding LED is flashing the indicated TEMP can be reviewed and programmed.

**SPECIFICATIONS –**

 **ELECTRICAL:**

| **Power requirements in watts at nominal line voltage** | **9 KWatts** |
| --- | --- |
| **Nominal current line voltage**  | **440 V/ Three phase**  |
| **Maximum Temperature**  |  **11000C** |
| **Mode of Heating** | **Thru’ Kanthal A1 Heating Element** |
| **Mode of Control Insulation** | **Thru’ Digital Temp. Controller** |
| **Insulation**  | **High Temp. HFK Bricks & Ceramic Fiber Blanket** |
| **Door**  |  **Pull Open Type with Ceramic Rope** |

 **OPERATIONAL – TEMPERATURE CONTROL**

| **Temperature Variation (Time)** | **+/- 0 C** | **0-5 0 C** |
| --- | --- | --- |
| **Temperature Deviation (spatial )** | **+/- 0 C** | **0-5 0 C** |
| **Readability / Set ability** | **0 C** | **10 C** |
| **Temperature Range**  | **0 C** | **26 0 C - 11000 C** |
| **Sensor Thermocouple**  |  |  |
| **Controller**  |  | **Solid state digital controller** |
| **Display** |  | **LED**  |
| **Adjustable alarm** |  | **Optional**  |

**Operating the furnace:**

* **Manual controller-**  Set the power controller dial to the desired setting, after allowing the furnace to heat, observe the temperature indicator, if the desired peak temperature is turn off the controller and allow for Self-cooling.

**Discussion**

* **Mode of Heat Ignition & Distribution in puta method**-
* Heat flow in Puta and in Sharava Samputa by Conduction method (heat flows from hot to cold surface) that, heat is applied to the Sharava Samputa from all side & there is clear temperature gradient between the Outer part & inner part of sharava samputa.Thedistribution of the heat takes place from cowdung cakes to cakes, cakes to sharava, sharava to pellets. By this arrangement of heat distribution it should get sustained uniform temperature surrounding the sharava .Due to the influence of the atmosphere and cowdung cakes ignition; there will be vary in attaining the maximum temperature in different successive Putas.
* On combustion, all cow dung cakes are not ignited simultaneously, one mass of cakes reaches maximum temperature and it starts falling another mass reaches this maximum temperature and takes over the temperature maintenance from the earlier mass, this way maintaining the plateau of maximum temperature but variation in the temperature deviation observed in successive gaja putas.
* **Mode of Heat Ignition & Distribution**  **in Horizontal Muffle Furnace -** Sharava was kept centre of the heating element chamber with the Distance of 3 inch from the sides and distance of 2 1/2 inch from the thermocouple, Surrounded by 4 Sets of Kanthal A-1 coils grooved with insulation bricks. The set temperature adjusted to the desired value as mean temperature of number of putas taken from the classical Bhasma putas. Attainment of temperature inside heating element chamber, sustains the study and uniform constant temperature for longer duration in each successive putas with temperature variation of 0- 100C /15 min.
* Temperature Pattern:
* First, Bhasma was prepared by Classical puta method which required number of puta. The temperature pattern was recorded at every 5 min interval for 6 hrs.Time taken for temperature to rise from base to peak level, time taken for peak to base level, peak range temperature, Peak stay time was recorded to each successive Putas. As per the statistic Mean Temperature of number of putas has been calculated this indicate –
* Peak temperature value in 0C reaches to particular hour .
* Average peak range Time was in hour/min.

 By taking expert opinion, the Mean peak temperature in 0C & Average peak range time has hour /min been applied to EHMF for the preparation of Bhasma.

* In EHMF Set temp. is adjusted manually to attain the temperature pattern & duration of the classical. The uniform controlled heat rise with 3 -5 0C / min temperature deviation noticed, with continuous Nominal current line Voltage –9 KW /440 V/ Three phase.
* Duration of Temperature:
* This can be understood by given example of vimala bhasma prepared by classical puta method and EHMF conducted in TGAMC,bellary,Karnataka in 2011. Here, the duration of classical puta of Vimala Bhasma completed in 6 Hrs & taken complete self cooling is 24 hour. Here, in present study, temperature goes to 800-9120C in 20 Gajaputa. But, peak range temperature time is less. This Puta is generally applied to Open atmosphere hence, its peak temperature is maintained for lesser duration.
* The Statistic mean peak temperature 7930C for 1hr duration applied over the EHMF. Here, time taken to reach peak Temperature was 2hr.15min (average) & maintained it for 1hr.After 1 hr temperature controller switched off & allowed for self cooling. The process completed in 45 hrs.
* Factors affecting Temparature range & Duration in Gajaputa: The difference in attaining peak temp. After ignition was found varying from 20 – 30min. in 20 puta. But, on and average 1hr.25min time taken for attaining peak in Gajaputa. This difference may be due to gradual inclination & spread of heat from one to another Cowdung cakes varies at each gaja puta procedure. As per cowdung cakes, quantum of heat differs from each vanopala respectively. Similarly Swangasheeta time also varies due to same rule.

 Average peak Strike temperature was high in some putas. It is due compact arrangement of Cowdung cakes in pit produce large quantum of heat. Difference in time taken for temp to rise from peak to base level & base to peak is with respect to onset time& per Cowdung cake Quantum.

* Difference in total average atmospheric temperature was due to Geographical position of the place of trail may be responsible for that atmospheric temperature on the day of performing Gajaputa. Temperature range time maintained for lesser duration i.e. about 50-55min
* **Duration of Self cooling in Classical Puta and Horizontal Muffle Furnace.**
* The total time duration required for burning of Gajaputa was 6 hours and total time required for complete self cooling was 24 hours. This Puta is generally applied in open atmosphere. Hence its cooling maintenance was lesser duration.
* But, in Muffle furnace time required for Self Cooling was 45 hours. It’s because of heating element chamber is made up of heat resistant refractory bricks .and it sustain the heat for longer duration.
* **Yield of Classical Gaja puta & Horizontal Muffle Furnace:**

The yield of Shodhita Vimala 87.5%, yield of Vimala Bhasma (Classical) & 63.6% and Vimala Bhasma 70%.

* **ANALYTICAL STUDY** -
1. **EDX SEM**- Results showed

**Vimala bhasma (classical)** - C 1.755%,O 21.605%,Si 3.76%,P 0.03%,S 0.275%,K 0.43%, Fe 64.11%,Co 0.52%,Cu 0.49%, Ag 0.3%.

 **Vimala bhasma (EHMF)** - C 1.365%,O 30.045%,Si 1.285%,S 0.505%,K 0.77%,Fe 64.07%,Ni 0.385%,Cu 0.385%,As 0.36%,Ag 0.525%, P 0.01%

1. **Particle Size:** Mean particle size of Vimala Bhasma(classical) is 2.13 µm, Vimala Bhasma (EHMF) 1.78 µm.
2. **XRD Results -** Both Vimala Bhasma prepared by Classical puta method & EHMF can be considered as Ferrous Sulphide & Ferric Oxide .The crystal structure was found to be Hexagonal & Cubic.

***In the present entitled study, Vimala Bhasma(EHMF) is Pharmaceutically very convenient to prepare and Shows good Analytical results compare to V.B.(Classical).***

**Conclusion –**

Ancient times our acharyas have documented pharmaceutical methods were not comprehensive. Revalidationof Bhasma preparation with contemporary parameters became essential for standardization. Hence, the advanced heating device electric muffle furnace replaced for conventional puta system for heating. Electric Muffle Furnace found comfortable owing to various aspects like no labor, easy operation and well regulated apparatus. Development of standard manufacturing methods helps in controlling quality related problems which make sure our Ayurveda much more acceptable to this world.