World Journal of Engineering Research and Technology
WJERT
www.wjert.org
SJIF Impact Factor: 5.924

MECHANICAL ENGINEERING IN ANCIENT EGYPT, PART 85: PIGMENTS INDUSTRY DURING THE NEW KINGDOM

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Article Received on 31/08/2019 **Article Revised on 21/09/2019** **Article Accepted on 11/10/2019**

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ABSTRACT

The objective of this paper is to investigate the development of mechanical engineering in ancient Egypt through the study of the pigments industry during New Kingdom. This study covers the use of the ancient Egyptians of a limited number of pigments and how they produced wonderful colored applications. Examples of using pigments during the 18th, 19th and 20th Dynasties are presented with identification of the pigments used.

KEYWORDS: Mechanical engineering history, ancient Egypt, pigments, New Kingdom, 18th, 19th and 20th Dynasties.

This is the 85th part in a series aiming at investigating the mechanical engineering technology in ancient Egypt. It investigates the application of the pigments production in ancient Egypt during the New Kingdom and how they could generate wonderful products and painted images in tombs and temples. The colors of their applications were really wonderful and could sustained environmental effects for thousands of years and look as they are painted now.

Hassaan, 2019 studied the pigments industry in ancient Egypt during both the Old and Middle Kingdoms. He presented a detailed survey for the studies covered the pigments industry in ancient Egypt published during the period from 2001to 2019.[1]

Pigments Applications during the 18th Dynasty

The 18th dynasty was the first dynasty of the New Kingdom continued from 1550 to 1292 BC.[2] As the 18th Dynasty was the wealthiest Dynasty in ancient Egypt, it is expected to find wonderful applications on using pigments of all types as will be illustrated by the following examples:

- The first example is a sarcophagus of a young Queen from the 18th Dynasty (1550-1293 BC) in display in the Luxor Museum of Ancient Egyptian and shown in Fig.1.[3] The designer used a limited number of pigments to produce a wonderful painted wooden coffin simulating the diseased young Queen. He used the Egyptian blue, red, white and black pigments.
- The second example is a 22 mm height carnelian turtle amulet from the 18th Dynasty (1550-1460 BC) in display in the Metropolitan Museum at New York and shown in Fig.2.[4] The turtle was cut and carved from one piece of red carnelian without any decorations or painting.

Fig. 1: Sarcophagus of a Queen from 18th Dynasty.[3] Fig. 2: Carnelian amulet from 18th Dynasty.[4]

- The third example is a faience plate with blue glaze from the 18th Dynasty (1550-1450 BC) in display in the Walters Art Museum at Baltimore, USA and shown in Fig.3.[5] The designer used two levels of the Egyptian blue, light one for the background and a dark one for the plant decorations inside the plate.
- The fourth example is fish-shaped decorated vessel from the 18th Dynasty (1549-1292 BC) in display in the British Museum and shown in Fig.4.[6] This is a master piece in the ancient Egyptian art and technology. The designer used two levels of the Egyptian blue, black and one level of the red pigment. Eventhough the number of colors are limited, however the product is really fantastic.

Fig. 3: Faience plate from the 18th Dynasty.[5] Fig. 4: Fish-shaped vessel from the 18th Dynasty.[6]

- The fifth example is a colored relief for Queen Ahmose-Nefertari, mother of Pharaoh Ahmose, the founder of the 18th Dynasty (1549-1514 BC) in display in the Egyptian Museum at Berlin and shown in Fig.5.[7] The designer used the black pigment for the Queen's skin, two levels of the red pigment for her crown, necklece and bracelets and the white and blue pigments for her dress and blue and red for her flail.
- The sixth example is an amphora-shaped glass perfume bottle from the 18th Dynasty in display in the Metropolitan Museum of Art at New York and shown in Fig.6.[8,9] The designer used a limited number of pigments to produce such a magnificant product. He used two levels of the Egyptian blue, black and yellow pigments. I didn't know how could they do it bearing in mind that this is a glass product. When I was preparing my paper about the glass industry in ancient Egypt (Part XVI.[10]) I sent to two professors specialized in glass science and glass technology asking about the manufacturing of this product. Both replied that it is not their specialization. I asked a frient who was a former Minister of Industry in Egypt, he said it is secret !!.

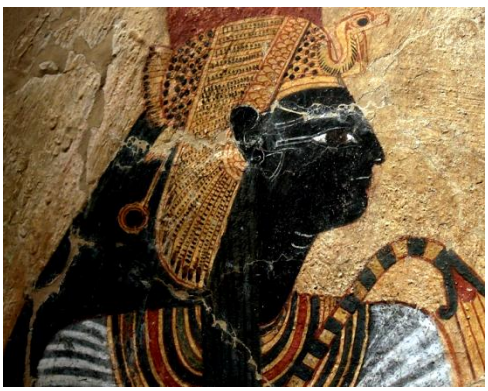
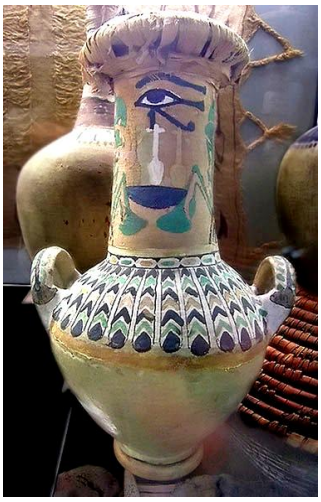


Fig. 5: Queen Ahmose-Nefertari from 18th Dynasty.[7] Fig.6: Glass bottle from 18th Dynasty.[9]

- The seventh example is a pottery storage jar from the tomb of Architect Kha, Overseer of Works during the reign of Amenhotep II and Thutmose IV Pharaohs of the 18th Dynasty

(1425-1350 BC) in display in the Egyptian Museum at Turin of Italy and shown in Fig.7.[11] The designer selected a limited number of Egyptian pigments to paint the pottery jar with scenes, symbols and patterns. The pigments used were the Egyptian blue (two levels), green, black and white.

- The eighth example is a scene from the tomb of Khaemouaset from reign of Amenhotep I, the 2nd Pharaoh of the 18th Dynasty (1524-1503 BC) in West Thebes (Der Abu el-Naga.[12] The designer used the red, blue, white and black pigments.



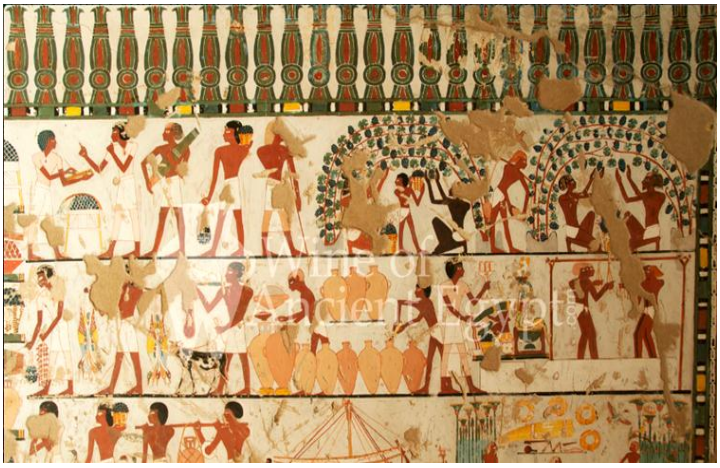


Fig. 7: Pottery jar of Kha from 18th Dynasty.[11] Fig. 8: Scene from Khaemouaset tomb from 18th Dynasty.[12]

- The ninth example is an 80 mm height glass vessel from the 18th Dynasty (1450-1350 BC) in Walters Art Museum at Baltimore and shown in Fig.9.[13] Again this is a wonderful designed, decorated and produced glass vessel. The designer used different levels of the blue pigment besides white and reg pigments. The decorations are marvelous.
- The tenth example is a paint palette for Amenemope, Vizier of Pharaoh Amenhotep II of the 18th Dynasty (1427-1401 BC) in display in the Cleveland Museum of Art at Ohio and shown in Fig.10.[14] The palette housed blue, green, red and black pigments.

Fig. 9: Glass vessel from 18th Dynasty.[13] **Fig.10: Paint palette from 18th Dynasty.[14]**

- The eleventh example is a faience vase inscribed for Pharaoh Amenhotep II of the 18th Dynasty (1427-1400 BC) in display in the British Museum and shown in Fig.11.[15] The whole body was colored by the Egyptian blue while the two cartouches of the Pharaoh were painted in black.
- The twelfth example is a grapes scene in the tomb of Sennefer, the Mayer of Thebes during the reign of Pharaoh Amenhotep II of the 18th Dynasty (1425-2398 BC) shown in Fig.12.[16] The designer used only one level of the yellow pigment and a black pigment.

Fig. 11: Faience vase from 18th Dynasty.[15] **Fig.12: Grapes scene from 18th Dynasty.[16]**

- The thirteenth example is a pottery storage jar from the tomb of Architect Kha from the 18th Dynasty (1425-1350 BC) in display in the Egyptian Museum at Turin and shown in Fig.13.[17] The whole body was painted by a yellow pigment and the shoulder and bottom parts were decorated by plant motifes using blue, red and black pigments. The mouth and

neck were painted using the Egyptian blue pigment.

- The fourteenth example is a colored scene in the tomb of Sennefer, the Mayer of Thebes during the reign of Pharaoh Amenhotep II of the 18th Dynasty (1425-2398 BC) shown in Fig.14.[18] The combination of pigments used in painting the scene generated a wonderful piece of art showing the Mayer setting and reflecting the glory of his country Egypt. The designer used different levels of the red pigment, white, black, blue and grey (black-white mix) pigments.

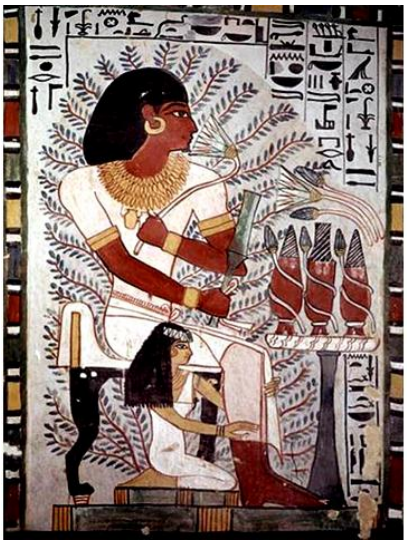


Fig. 13: Pottery jar from 18th Dynasty.[17] Fig. 14: Sennefer scene from 18th Dynasty.[18]

- The fifteenth example is a faience blue saucer from the 18th Dynasty (1400-1325 BC) in display in the Egyptian Museum at Cairo and shown in Fig.15.[19] The faience paste was mixed by an Egyptian blue pigment while an inlay or painted scene was applied in the centre of of the internal surface of the saucer.
- The sixteenth example is a granite statue of Thutmose IV, the 8th Pharaoh of the 18th Dynasty (1398-1388 BC) in display in the Egyptian Museum at Cairo and shown in Fig.16.[20] The designer planed to produce a black statue for the Pharaoh. He prephared to select a natural material having the black color which is the black granite. By this approach he avoided any paunting or inlay processes.

Fig.15: Faience saucer from 18th Dynasty[19]

Fig.16: Statue of Thutmose IV from 18th Dynasty [20].

- The seventeenth example is a colored scene from the tomb of Nakht, a Scribe and Astronomer of Amun for Pharaoh Thutmose IV of the 18th Dynasty (1398-1388 BC) shown in Fig.17.[21] The designer showed the Scribe hunting in the marsh and accompanying his family with him. He used the blue, red, white and yellow pigments in painting the scene.
- The eighteenth example is a colored scene of the daughter of Scribe Nakht in his tomb, Dynasty 18 (1398-1388 BC) shown in Fig.187.[22] The designer showed the girl well dressed and ornamented. He used the black, red, white and red pigments in painting the image of Kha's daughter.

Fig. 17: Hunting scene from 18th Dynasty.[21]

Fig. 18: Girl image from 18th Dynasty.[22]

- The ninteenth example is a sowing scene in the tomb of Menna, Scribe and Overseer of Fields of Amun during the reign of Thutmose IV from the 18th Dynasty (1398-1388 BC) shown in Fig.19.[23] The designer generated this personal scene using the pigments: white, black, red, three levels of green and blue.

- The twentieth example is a pottery libation bottle for Pharaoh Thutmose IV of the 18th Dynasty (1398-1388 BC) in display in the Brooklyn Museum at New York and shown in Fig.20.[24] The designer used the blue pigment mixed with the pottery paste (or painted) for the whole body of the bottle. He used the black pigment to decorate the bottle shoulder and to draw the Cartouche of the Pharaoh.
- The twenty-first example is a pottery jar for Amenhotep III, the 9th Pharaoh of the 18th Dynasty (1390-1353 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.20.[25] The designer decorated the most of the jar outside surface by plant and other shapes motifs painted using the Egyptian blue pigment.

Fig. 19: Sowing scene from 18th Dynasty.[23]

Fig. 20: Libation bottle from 18th Dynasty.[24]

Fig. 21: Pottery jar from 18th Dynasty.[25]

- The twenty-second example is a shabty of the Lady of the House during the 18th Dynasty (1390-1352 BC) in display in the Brooklyn Museum at New York and shown in Fig.22.[26] The designer used the blue, red, white and black pigments in painting the shabty in a highly professional way.
- The twenty-third example is an 175 mm length painter's palette for Pharaoh Amenhotep

III of the 18th Dynasty (1388-1350 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.23.[27] The palette was labelled by the Carouche of the Pharaoh and contained a number of pigments in its pools including the blue, red and black pigments.

- The twenty-fourth example is a wall painting from the tomb of Pharaoh Amenhotep III of the 18th Dynasty (1390-1353 BC) shown in Fig.24.[28] This was a rich procession scene produced using red, blue, black and white pigments.

Fig. 22: Lady shabty from 18th Dynasty.[26]

Fig. 23: Palette from 18th Dynasty.[27]

Fig. 24: Painting in the tomb of Amenhotep III from 18th Dynasty.[28]

- The twenty-fifth example is a glazed-pottery vase of Queen Tiye, Royal Great Wife of Pharaoh Amenhotep III of the 18th Dynasty (1390-1353 BC) in display in the Louvre Museum at Paris and shown in Fig.25.[29] The lid had motifs painted in blue and red while

the body was inscribed by three Cartouches and to lines text inside a frame all painted in blue. The body was glazed by a yellow pigment.

- The twenty-sixth example is an amphora from the 18th Dynasty(1380-1300 BC) in display in the Walters Art Museum at Baltimore and shown in Fig.26.[30] The Egyptian blue was used to color of the amphora from inside and outside (may be through the manufacturing process if it was pottery or faience.

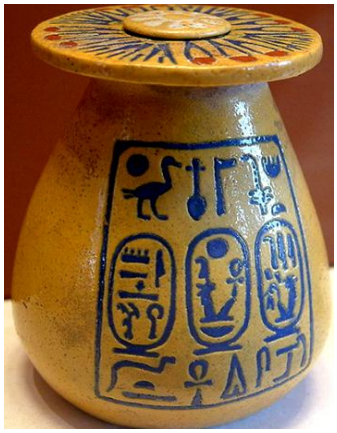


Fig. 25: Royal vase from 18th Dynasty.[29]

Fig. 26: amphora from 18th Dynasty.[30]

- The twenty-seventh example is handled-glass cup produced during the reign of Akhenaten the 10th Pharaoh of the 18th Dynasty (1351-1334 BC) displayed by the Egyptian Vitual Museum and shown in Fig.27.[31] The designer used the Egyptian blue mixed with glass paste and decorated the cup externally by net-patterns in green while the base was in black and decorated by a yellow band. Of course too many readers will ask about the manufacturing technique where of us wait the research of the glass experts to give answers.
- The twenty-eighth example is a 0.935 m length ceramic wine jar from the 18th Dynasty (1353-1190 BC) in display in the Penn Museum at Pennsylvania, USA and shown in Fig.28.[32] The designer used the Egyptian blue to decorate the jar through painting circular bands on both lid and body of the jar.

Fig. 27: Glass cup from 18th Dynasty.[31] Fig.28: Wine jar from 18th Dynasty.[32]

- The twenty-ninth example is a 175 mm height glass bottle from the reign of Pharaoh Akhenaten of the 18th Dynasty (1353-1336 BC) in display in the Metropolitan Museum at New York and shown in Fig.29.[33] The bottle was nicely decorated by unique motifs using two levels of the blue pigment and the white pigment.
- The thirtieth example is scene for hunting in the marshes from the tomb of Nebamun, Scribe and Grain Accountant during the 18th Dynasty (1350 BC) in display in the British Museum at London and shown in Fig.30.[34] The designer planned for this wonderful scene using the blue, red, white, black and black-white mix (grey) pigments.

Fig. 29: Glass bottle from 18th Dynasty.[33] Fig. 30: Hunting scene from 18th Dynasty.[34]

- The thirty-first example is the 540 mm height golden mask of Tutankhamun, the 13th

Pharaoh of the 18th Dynasty (1332-1323 BC) in display in the Egyptian Museum at Cairo and shown in Fig.31.[35] The designer used natural materials to produce this marvelous unit providing yellow, blue, black, grey and red colors.

- The thirty-second example is drinking cup for Pharaoh Tutankhamun of the 18th Dynasty (1332-1323 BC) in display in the Egyptian Museum at Cairo and shown in Fig.32.[36] The cup was inscribed in four locations using a black pigment.
- The thirty-third example is a water pottery bottle for Pharaoh Tutankhamun of the 18th Dynasty (1332-1323 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.33.[37] The bottle was painted by red and blue pigments. It was possible that the red pigment was mixed with the paste of the bottle during production.
- The thirty-fourth example is a wall painting in the tomb of Horemheb, the 15th Pharaoh of the 18th Dynasty (1319-1292 BC) in the Valley of the Kings at Luxor and shown in Fig.34.[38] The designer used the red, blue, black, white and blue pigments in producing such wonderful scene.

Fig. 31: Mask from 18th Dynasty.[35]

Fig. 32: Drinking cup from 18th Dynasty.[36]

Fig. 33: Bottle from 18th Dynasty.[37]

Fig. 34: Tomb scene from 18th Dynasty.[38]

Pigments Applications during the 19th Dynasty

The 19th dynasty was the second dynasty of the New Kingdom continued from 1292 to 1189 BC and was ruled by eight Pharaohs.[39] Some of the applications of pigments during the 19th Dynasty are illustrated by the following examples:

- The first example is a pottery jar from the 19th Dynasty (1305-1162 BC) in display in the Louvre Museum at Paris and shown in Fig.35.[40] The designer mixed the pottery paste with a blue pigment while decorated the outside surface by motifs painted in black.
- The second example is a faience necklace counterpoise from the 19th/20th Dynasties (1295-1070 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.36.[41] The designer used to levels of the blue pigment mixed with the faience paste while selected deep engravings to decorate 70% of the counterpoise surfaces.

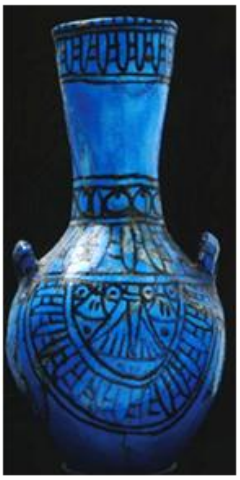


Fig.35: Pottery jar from 19th Dynasty [40].

Fig.36: Faience necklace counterpoise from 19th Dynasty [41].

- The third example is a harvesting scene in the tomb of Sennedjem, Artisan during the reign of Pharaoh Seti I and Ramses II of the 19th Dynasty (1290-1213 BC) shown in Fig.37.[42] The designer used two levels of the red pigment, black, white and blue pigments.
- The fourth example is a painted relief in the temple of Pharaoh Seti I from the 19th Dynasty (1295-1279 BC) in Abydos and shown in Fig.38.[43] The designer used two levels of the red pigment, two levels of the blue pigment, yellow and white pigments in producing the relief.
- The fifth example is a wall painting in the tomb of Queen Nefertari, Great Royal Wife of Pharaoh Ramses II of the 19th Dynasty (1279-1213 BC) in the Valley of the Queens and

shown in Fig.39.[44] The designer used the red, black and white pigments in producing this nice scene.

- The sixth example is a wine production scene from the tomb of Neferrenpet, Vizier and High Priest of Ptah during the reign of Pharaohs Ramses II and Seti II of the 19th Dynasty (1279-1197 BC) in the Tombs of the Nobles at Luxor and shown in Fig.40.[45] The designer used two levels of red, black, two levels of blue, yellow and black pigments.

Fig. 37: Harvesting scene from 19th Dynasty.[42] Fig. 38: Temple relief from 19th Dynasty.[43]

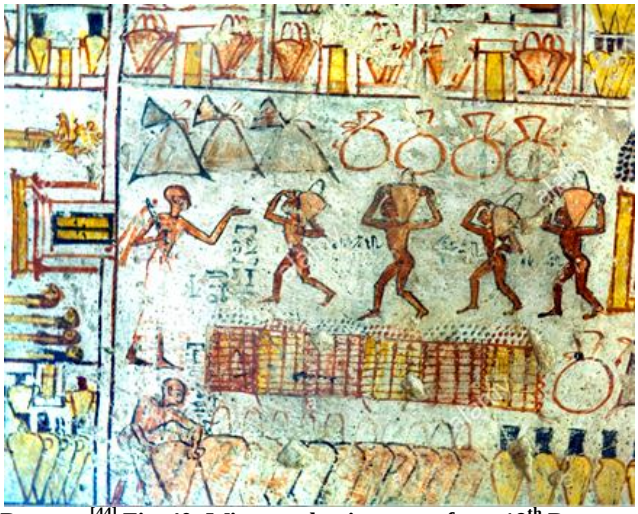


Fig. 39: Scene in Nefertari tomb from 19th Dynasty.[44] Fig. 40: Wine production scene from 19th Dynasty.[45]

- The seventh example is a wall painting scene from the Temple of Beit El-Wali in Nubia built by Pharaoh Ramses II of the 19th Dynasty (1279-1213 BC) shown in Fig.41.[46] The scene registered one of Ramses II battles against Nubians. The designer used red, two levels of blue, black and white pigments in producing such a wonderful military scene.

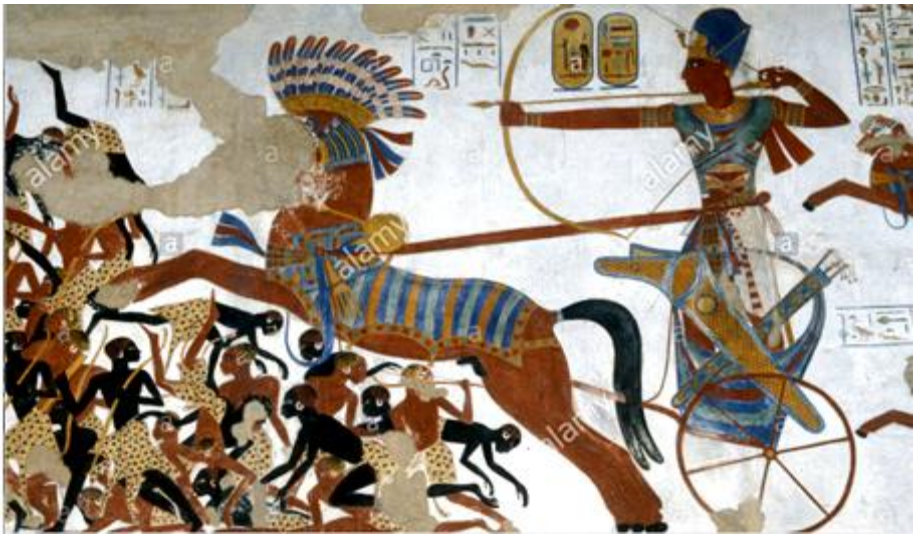


Fig. 41: Temple scene from 19th Dynasty.[46]

- The eighth example is a pottery jar from the tomb of Sennedjem, Artisan of Pharaoh Ramses II of the 19th Dynasty (1279-1213 BC) in display in the Metropolitan Museum of Art at New York and shown in Fig.42.[47] The designer decorated the jar by motifs of the jar neck and shoulder using the black, red and blue pigments.

Fig. 42: Pottery jar from 19th Dynasty.[47]

Pigments Applications during the 20th Dynasty

The 20th dynasty was the third dynasty of the New Kingdom continued from 1189 to 1077 BC and was ruled by ten Pharaohs.[48] Some of the applications of pigments during the 20th Dynasty are illustrated by the following examples:

- The first example is a 113 mm height faience shabty of Harkhebit from the 19th /20th Dynasties (1292-1075 BC) in display in the Brooklyn Museum at New York and shown

in Fig.43.[49] The designer colored the shabty by mixing its paste by the Egyptian blue while inscribed its front surface using a black pigment.

- The second example is an colored wall image for Pharaoh Ramses III and his son Amen-hor-khepeshef from the 20th Dynasty (1186-1155 BC) in display in the tomb of Amen-hor-khepeshef number 85 in the Valley of the Queens at Luxor and shown in Fig.44.[50] The designer planned for his Royal scene using the red, blue, black, yellow and white pigments.

Fig. 43: Shabty of Harkhebit from 19th /20th Dynasties.[49] Fig. 44: Tomb wall scene from 20th Dynasty.[50]

- The third example is a colored wall relief for Pharaoh Ramses III of the 20th Dynasty (1186-1155 BC) in display in Khonsu Temple at Karnak of Luxor and shown in Fig.45.[51] The designer used the pigments: red, blue, yellow and white in producing this Royal relief.
- The fourth example is a faience offering cup for Pharaoh Ramses III of the 20th Dynasty (1186-1155 BC). It was a Private Collection of Mr. Gardner from San Francisco and shown in Fig.46.[52] The designer mixed the faience paste with a green pigment and used a black pigment to inscribe the outside surface of the cup using the painting process.

Fig. 45: Wall relief from 20th Dynasty.[51] Fig. 46: Faience cup from 20th Dynasty.[52]

- The fifth example is a silver finger ring for Pharaoh Ramses IV of the 20th Dynasty (1155-1149 BC) in display in the Brooklyn Museum at New York and shown in Fig.47.[53] The designer used the natural silver white as the color of his Royal product.
- The sixth example is a greywacke statue of Pharaoh Ramses IV of the 20th Dynasty (1155-1149 BC) in display in the British Museum and shown in Fig.48.[54] The designer used the natural black pigment of the greywacke stone as a color for his statue.

Fig. 47: Finger ring from 20th Dynasty.[53] Fig. 48: Greywacke statue from 20th Dynasty.[54]

- The seventh example is a shabty for Pharaoh Ramses IV of the 20th Dynasty (1155-1149 BC) in display in the Louvre Museum at Paris and shown in Fig.49.[55] The designer used

the yellow color as the main color of his product, two levels of the red pigment and the black pigment for the inscriptions on the shabty dress.

- The eighth example is a signet finger ring of Pharaoh Ramses VI of the 20th Dynasty (1145-1137 BC) in display in the Metropolitan Museum of Art and shown in Fig.50.[56] The designer used the natural yellow pigment of gold as a color for his product.

Fig. 49: Royal shabty from 20th Dynasty.[55] Fig. 50: Signet ring from 20th Dynasty.[56]

- The ninth example is a scene for Pharaoh Ramses IX of the 20th Dynasty (1129-1111 BC) in display in his tomb KV6 in the Valley of Kings at Luxor of Egypt and shown in Fig.51.[57] The designer used two levels of the red pigment, black and white pigments in painting such a neat portrait for the Pharaoh.
- The tenth example is a golden signet finger ring of Pharaoh Ramses X of the 20th Dynasty (1111-1107 BC) in display in the Metropolitan Museum of Art and shown in Fig.52.[58] The designer used the natural yellow pigment of gold as a color for his product.

Fig. 51: Scene for Ramses IX from 20th Dynasty.[57] Fig. 50: Signet ring of Ramses X from 20th Dynasty.[58]

CONCLUSION

- This paper investigated the evolution of mechanical engineering in ancient Egypt through the use of pigments during the New Kingdom of ancient Egypt.
- The study covered a time span from 1550 to 1077 BC.
- Wonderful applications of pigments were practiced during the 18th Dynasty.
- Those applications covered: coffins, amulets, plates, vessels, bottles, jars, amphorae, cups, vases, saucers, tomb scenes, palettes, shabties and masks.
- The applications of pigments during the 19th Dynasty included: jars, necklace counterpoise, tomb and temple scenes and shabties.
- The applications of pigments during the 20th Dynasty included: shabties, tomb and temple scenes, cups, finger rings and statues.
- The ancient Egyptians during the New Kingdom practiced deeply using: blue, red, white, black, yellow and mixed pigments.
- They used two or more levels of some pigments.

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