Principle Analysis and Key Maintenance Technologies for Medium Wave Broadcast Transmitting Antennas (Postprint)

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Date: 2023-10-08T00:00:00+00:00

Abstract

With the goal of promoting the development of the wireless broadcasting industry, this paper analyzes medium-wave broadcast transmitting antennas. It first introduces their fundamental principles, then elaborates on their internal structure, and finally summarizes key maintenance technologies and methods, aiming to provide support for the smooth execution of future work related to medium-wave broadcast transmitting antennas.

Full Text

Preamble

ChinaXiv Cooperative Journal

Research on Principle Analysis and Key Maintenance Technologies of Medium-Wave Broadcast Transmitting Antennas

Abstract: With the premise of promoting the development of the wireless broadcast industry, this article analyzes medium-wave broadcast transmitting antennas. It first introduces their basic principles, then elaborates on their internal structure, and finally summarizes key maintenance technologies and methods, aiming to provide support for the smooth implementation of future medium-wave broadcast transmitting antenna work.

Keywords: medium-wave broadcast transmitting antenna; principle; key maintenance technologies

CLC Number: TH827

Document Code: A

Article ID: 1671-0134(2018)03-067-02

DOI: 10.19483/j.cnki.11-4653/n.2018.03.028

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1. Antenna Types and Characteristics

1.2 Grounded Self-Supporting Medium-Wave Tower Antenna

This antenna type can replace traditional parallel-feed antennas, addressing instability factors such as high feedline tension, complex structure, and significant temperature variation. It solves problems where the tower body bears the weight of both FM/TV antennas and feedlines, resolves uneven stress distribution and complex structural requirements, and overcomes the fixed feed-point limitation of traditional parallel-feed antennas.

1.3 Sleeve-Type Broadband Conical Top-Loaded Medium-Wave Compact Antenna

Building upon traditional antenna theory, this design utilizes sleeve antenna theory, antenna slenderness ratio principles, conical top gradual transition principles, and lumped parameter theory to significantly reduce antenna volume while substantially improving radiation efficiency. Through repeated testing, it successfully achieves goals of reduced footprint and expanded operating bandwidth, representing a revolutionary transformation in medium-wave antenna technology. Using antenna height as a parameter characteristic curve, the optimal height is calculated to be 0.625λ[2].

1.4 Self-Supporting Double-Cone Antenna

This antenna can replace 76-100 meter self-supporting medium-wave antennas and traditional medium-wave antennas, enabling dual-frequency tower sharing (when $f1/f2 \geq 1.25$).

2. Composition of Medium-Wave Broadcast Transmitting Antennas

Medium-wave broadcast transmitting antennas primarily consist of four components: (1) vertical dipole single-mast guyed antenna; (2) tower base insulation; (3) feedline; and (4) antenna tuning network connected to the tower base[1]. The ground network uses the tower base as its center point, with copper mesh distributed radially in the soil at a depth of 0.8 meters, serving to reduce ground current losses and enhance antenna radiation efficiency.

3. Key Structural Components

3.1 Tower

Towers serve as the foundation for antennas. A stable and safe tower enables digital audio broadcasting and multi-frequency tower sharing (f1/f2 $\geq$ 1.25), providing guarantee for transmission stability. Therefore, careful calculation is required when selecting towers for broadcast stations to ensure dimensions and specifications match transmitter power parameters and guarantee effective signal propagation. The typical medium-wave frequency range is 531-1602 kHz, corresponding to wavelengths of 187-564 meters, and these parameter standards must be fully considered in calculations.

3.2 Ground Network

Ensuring antenna power is crucial for program quality, as losses occur during power transmission. Several factors contribute to these losses: first, antenna conductors directly affect propagation quality; second, the tower base insulator; and third, ground return currents, which account for the largest proportion. While antenna inherent losses and high-frequency losses are not severely impactful, ground losses have more significant effects.

To ensure optimal antenna power performance, ground network design is critical. When antenna radiated electromagnetic waves propagate along the earth's surface, they create surface currents that affect ground conductor effectiveness, preventing current transformation and decomposition. This results in antenna radiation energy loss, reduced coverage area, decreased accuracy of electric field coverage directionality, and impacts on antenna radiation resistance and input power. Practice shows that when radial distance $r = 0.5\lambda$, ground currents stabilize. Therefore, the optimal ground network radiation radius is 0.5λ, and the radius should be maintained between 0.3λ and 0.5λ of the operating wavelength[3]. Ground network installation must be completed before tower foundation pouring to ensure location selection does not affect equipment installation.

3.3 Guy Wires

Guy wire quality directly determines final propagation quality, requiring strict design of planar structures. Based on different tower types and cross-section characteristics, design and construction quality must be improved to ensure tension meets standards. During the design phase, for rectangular tower cross-sections, guy wires should be installed in four directions with equal force distribution to ensure tower stability and safety. For triangular cross-sections, guy wires should be installed at the three corners to meet tension requirements. Regardless of configuration, the purpose is to meet power demands.

To achieve optimal power performance, guy wire inclination angles must be reasonable, with 60° being optimal. If the angle is too large, it increases guy wire tension and tower axial forces, reducing tower stability and causing oscillation during operation, affecting signal propagation quality. If the angle is too small, it increases construction width and wastes area. Therefore, to fully meet propagation requirements while saving space, angle design must be based on actual site conditions.

4. Key Maintenance Technologies for Medium-Wave Broadcast Transmitting Antennas

Currently, China's medium-wave broadcast transmitting antenna technology is increasingly mature, with relevant institutions establishing more detailed specifications. The wireless broadcast industry must perform maintenance on medium-wave broadcast transmitting antennas, typically on weekly, monthly, and annual cycles. Maintenance facilitates full performance realization and high-efficiency operation. In addition to the antenna itself, maintenance includes ground networks, masts, insulator bases, and other components.

Different components require different maintenance techniques. For external components such as bases, masts, and towers, anti-corrosion materials like paint are typically applied to prevent corrosion from prolonged exposure. For mast guy wires, tension values must be checked periodically to optimize mast structural design. For small components like bolts that connect towers to bases, careful inspection is required to prevent corrosion; corroded bolts must be replaced promptly, with particular attention to corroded bolts and fractured mast ropes. Ground anchors require periodic sampling and testing to ensure basic performance.

For electrical maintenance, three key aspects must be addressed: First, process information displayed on antenna control panels, especially from control centers, with enhanced supervision and verification[4]. Second, inspect idle medium-wave broadcast components, promptly address issues, and perform maintenance. Third, use resistance testers to check mast base and ground network performance, collect comprehensive performance data, analyze the information to identify problems, and apply effective solutions.

Identifying interference sources and eliminating external influences during signal input/output is crucial to prevent distortion and signal loss. Interference sources must be investigated according to existing problems to avoid external impacts on medium-wave broadcast signals. Since maintenance involves various antenna types with different principles, appropriate hardware maintenance techniques must be applied accordingly.

Additionally, the broadcast industry often faces constraints from economic conditions, leading to a severe shortage of professional technical talent that limits actual maintenance and operations. Therefore, the industry must enhance maintenance awareness, prioritize staff technical competence, and organize professional training to continuously improve expertise, reduce equipment failure rates, minimize faults, and ensure stable operation. For maintenance personnel, their technical capabilities require improvement; the industry must focus on enhancing professionalism through technical training to understand both basic maintenance and the latest medium-wave broadcast technologies. Mastering new achievements reduces failure rates and prevents equipment losses due to inadequate skills.

During development, the industry must coordinate internal staff, with managers strengthening supervision to improve operational standardization and reduce costs from non-standard operations. During equipment maintenance, establish maintenance mechanisms based on actual conditions to ensure standardized procedures and improve safety and reliability.

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Note: Figure translations are in progress. See original paper for figures.